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Infill Development Noise Control Challenges (And Noise Modeling Limitations) - A Case Study Of A Development Adjacent Highway 401

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1. INTRODUCTION

This paper deals with the development of a residential subdivision within lands that were formerly used as a hydro transmission corridor. A portion of these lands abuts Highway 401, a provincial freeway that ranks as one of the busiest highways in North America.

The former hydro corridor is located in an existing single family residential subdivision that was developed in the 1960's. Sound barriers were retrofitted along Highway 401 by the Ministry of Transportation in the late 1970's. These barriers are 3.0 metres in height east and west of the former hydro corridor, and provide outdoor noise abatement for the existing subdivision located adjacent Highway 401. The existing Highway 401 sound barrier steps down to 2.4 metres in height where it crosses the former hydro corridor.

The lands located between Highway 401 and Lowcrest Boulevard will consist of twelve two-storey dwelling units fronting on Lowcrest Boulevard, and a stormwater management pond, located between the rear yards and the Highway 401 right-of-way. A noise control study was required as a condition of approval. The objective of the noise control study was to recommend appropriate outdoor and indoor noise control measures for these lands.

2. INITIAL ANALYSIS

The Ministry of Transportation provided traffic information for this section of Highway 401. Existing SADT (Summer Average Daily Traffic) volumes are approximately 370,000 vehicles per day, while the 20 year projected volumes are estimated to be 570,000 vehicles per day (SADT). This reflects constant two percent growth in traffic over the next twenty years. Sound levels on the site were predicted using the Ministry of the Environment (MOE) "STAMSON" Computer Program for Road Traffic Noise Assessment.

The sound level analysis results indicated that the first row of single family lots located north of Highway 401, would require an 11 metre high sound barrier wall in order to achieve a daytime outdoor sound level ($L_{eq}16h$) of 60 dBA. This sound level is within a five decibel tolerance of the MOE objective of 55 dBA, and is considered acceptable by the City of Toronto. The sound barrier would be located adjacent the Highway 401 right-of-way and would include barrier returns along the east and west side of the site.

Although this height of sound barrier is feasible from a design perspective (but just barely), it would be very costly and would have extreme visual and aesthetic impacts on both the proposed dwellings and the existing adjacent dwellings. Furthermore, it cannot be considered a practical noise control solution, especially in light of 3.0 metre high sound barrier wall that protects the existing subdivision on either side of the site.

3. SOUND LEVEL MEASUREMENTS

Discussions were then held with staff from the City of Toronto Noise Unit regarding this issue. It was suggested that existing Highway 401 sound levels be monitored to determine the existing outdoor sound levels on the site, and to compare this with the existing sound levels predicted by the STAMSON computer noise modeling program. The sound level measurements were performed at a location that would correspond to the rear yard amenity area of one of the dwelling units.

The results of the sound level monitoring indicated that the 24 hour sound level in the future rear yard amenity area was 65.8 dBA. However, the STAMSON model predicted that the 24 hour sound level should be 70.8 dBA, which is 5.0 dB greater than measured. The modeled sound levels were based on existing Highway 401 traffic volumes and included the attenuation provided by the existing 2.4 metre high Highway 401 sound barrier. During the time of the sound level measurements, Highway 401 exhibited normal traffic conditions (ie. no major traffic incidents) and weather conditions were within acceptable parameters (eg. low winds and clear conditions).

At first glance, these findings seem surprising. Generally, sound levels predicted by the STAMSON model are within ± 2 dB of measured values. The author's experience is that in many cases the discrepancy is less than 1 dB, when comparing modeled to measured sound levels. However, observations of Highway 401 provide a likely reason for the discrepancy in measured and modeled sound levels. The STAMSON noise model is derived from the U.S. FHWA (Federal Highway Administration) STAMINA noise predic-

tion model. The STAMINA noise model was developed from numerous sound level measurements of vehicles travelling on highways. Reference emission sound levels were established based on traffic travelling at constant speed in cruise mode under free-flow conditions. The emission levels were referenced to posted speed limits.
Under free-flow traffic conditions on freeways, the average speed of traffic is generally 15 to 20 km/h faster than the posted speed limit. However, the section of Highway 401 that is located adjacent the development site, suffers from significant traffic congestion for extended periods of time. During morning and evening roadway peak periods, this section of highway exhibits stop and go conditions. Consequently, the average vehicle speeds are not as high as they would be under 24 hour free-flow conditions. The STAMSON model does not account for this, thus it will over-predict the sound levels.

Another possible contributing factor to the discrepancy might be the attenuation contribution of the roadside "Jersey" concrete safety barriers that separate the east and westbound core-collector lanes. These safety barriers are approximately one metre in height. Since the STAMSON model uses a blended source height, derived from the average of the passenger car, medium truck and heavy truck source heights, the blended Highway 401 traffic source height of 1.6 metres would be higher than the "Jersey" barrier. Therefore, the "Jersey" barrier would not provide any noise attenuation. In reality, the "Jersey" barriers could be expected to provide some attenuation of both passenger car and medium truck noise, since the source heights of these vehicle types are in the order of 0.5 metres.

4. FURTHER ANALYSIS

Further discussions were held with the City of Toronto Noise Unit staff. It was agreed that a sound barrier height of 4.0 metres would be considered a practical height limit, in light of the existing 3.0 metre high Highway 401 sound barriers on either side of this development.

The STAMSON noise analysis for the development was revised using the revised barrier height of 4.0 metres and applying the sound level measurement adjustment factor of -5.0 dB. The revised analysis indicated that the 4.0 metre high sound barrier would result in attenuated rear yard daytime sound levels (L_{eq}16h) of 63 to 64 dBA under Year 2021 SADT conditions. However, these sound levels are based on a continuing two percent per annum growth rate in Highway 401 traffic volumes over the next twenty years. Yet Highway 401 is today built to its ultimate configuration and operates at capacity for many hours of the day. Therefore, it is unlikely that such traffic growth can be realized over the next twenty years but if it did occur, traffic conditions would be extremely congested. This would result in vehicles travelling at speeds much lower than the posted 100 km/h speed limit. Consequently, the rear yard sound levels would be significantly lower than predicted by the STAMSON model.

Because of this, a second analysis was performed based on current traffic volumes, but with the inclusion of the 4.0 metre high Highway 401 sound barrier. The results of this analysis indicated that the attenuated rear yard daytime sound levels (L_{eq}16h) would be 61 to 62 dBA. These sound levels are still slightly in excess of the generally accepted tolerance value of 60 dBA for outdoor amenity areas, but this difference would not typically be discernible. Given the unique situation of this infill development in an existing mature residential neighbourhood and the practical considerations of barrier height, the 4.0 metre high sound barrier was recommended for this development to control Highway 401 noise. The recommended noise control measures were reviewed and approved by the City of Toronto.

5. CONCLUSIONS

Based upon the results of the sound level measurements and analysis, the recommended 4.0 metre high Highway 401 sound barrier can be considered an appropriate outdoor noise control measure for this development. It is similar in magnitude to the existing sound barriers on either side of the site yet will provide a better sound environment than exists for the adjacent existing dwellings. Furthermore, it will not be large enough to create unacceptable aesthetic and visual impact to the development residents, nor will it be impractical to implement. In light of all of the constraints to redeveloping this property, the recommended noise control measures represent the best compromise. Finally, this study shows that care must be taken when using STAMSON to model traffic noise when the road operates under congested traffic conditions for an extended period of the day.

6. REFERENCES

- "FHWA Highway Traffic Noise Prediction Model". U.S. Federal Highway Administration, Washington D.C., December 1978.

- "ORNAMENT – Ontario Road Noise Analysis Method for Environment and Transportation, Technical Document", Noise Assessment and Systems Support, Approvals Branch, Ministry of the Environment, October 1989.