APPENDIX B: GUIDELINES
APPENDIX B
MOE/TTC PROTOCOLS

MOEE/TTC
DRAFT
PROTOCOL FOR NOISE AND
VIBRATION ASSESSMENT FOR THE
PROPOSED SCARBOROUGH RAPID
TRANSIT EXTENSION

May 11, 1993
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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:

\[ L_{D,eq} \] 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:

\[ L_{N,eq} \] is the nighttime equivalent sound level. The applicable time period is from 23:00 to 07:00 hours.

Point of Reception:

\[ \text{Daytime:} \quad 07:00 - 23:00 \text{ hours} \]

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

\[ \text{Nighttime:} \quad 23:00 - 07:00 \text{ hours} \]

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 façade of the premises.

Passby Sound Level, \[ L_{pa,eq} \]

Within the context of this document, the passby sound level is defined as the A-weighted equivalent sound level, \[ L_{pa} \] (Reference 2) over the passby time interval.
sources. Trains idling in maintenance yards and storage facilities 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, $L_{eq,day}$.
2) Nighttime equivalent sound level, $L_{eq,night}$.
3) Passby Sound Level, $L_{pass}$.

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 $L_{eq,day}$, 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 $L_{eq,night}$, whichever is higher.

**PASSBY SOUND LEVEL:**

The limit at a point of reception for predicted $L_{pass}$ 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 $L_{max}$ from train 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 in consultation with MTO and MOEE.

3.0 ANNUAL FACILITIES

Predicted noise impacts from annual 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 CEA Standard 2107.55.

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 11). 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.
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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.

1.6 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 centerline, where vibration engineering 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 train 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/s, mitigation methods shall be applied during the detailed design to meet this criterion to the extent technologically, economically, and administratively feasible.

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 MVCIL.

References


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

SS Wilson Associates Consulting Engineers
MOEE/TTC
DRAFT
PROTOCOL FOR NOISE AND VIBRATION ASSESSMENT FOR THE PROPOSED WATERFRONT WEST LIGHT RAIL TRANSIT LINE
November 11, 1993

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PROTOCOL FOR NOISE AND VIBRATION ASSESSMENT

PART A: PURPOSE

The Toronto Transit Commission (TTC) and the Ministry of the Environment and Energy (MOE) recognize that transit facilities produce noise and vibration which may affect neighbouring properties within sensitized areas. This document identifies the framework within which criteria will be applied for limiting roadside air-borne noise, ground-borne noise and vibration from the TTC's proposed southwest light rail transit line (the "Line"). The proposed line is to run from Spadina and Queen's Quay West to the GNR Building on King Street East and from the North Loop to Legion Road. 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 to be utilized during implementation of the Line.

The pass-by sound levels and vibration velocities in this protocol have been developed specifically for the Line and this protocol is not to be applied retrospectively to existing TTC transit lines, routes or facilities. Including the existing lines with which this Line will interface, 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 ICES and the Ministry of Transportation (MTO). Following performance to noise and vibration levels are also being conducted by TTC. Upon completion of these studies, the TTC may adopt the assessment criteria and methods in this protocol to modify them as required in consultation with ICES and the Ministry of Transportation (MTO).

PART B: GENERAL

During design of the Line, predicted roadside 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 recognized that wheel/rail or rail corrugation will inevitably occur and will temporally 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 endeavors to minimize the noise and vibration impacts associated with its transit operations and is committed to providing good operating conditions to the public at large, economically and administratively feasible.

PART C: DEFINITIONS

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

Auxiliary Facilities:

Subsidy locations associated with either the housing of personnel or equipment engaged in TTC activities associated with maintenance and repair. Examples of auxiliary facilities include, but are not limited to, subway maintenance loops, mechanical equipment plants, maintenance and storage facilities, and vehicle storage and maintenance facilities.

Passby Time Interval:

The pass-by time interval of a vehicle 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 wheel passes a reference point. The end of the pass-by is defined as that point in time when the last wheel of the vehicle passes 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 pass-by time interval will be defined in the prediction and measurement methods being developed.
PART D. AERODROME NOISE

5.0 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 context the ambient is taken to be the noise from road traffic and existing industry. The ambient specifically excludes transient noises from aircraft and railways, except for pre-existing TRG rail operations.

Daytime Equivalent Sound Level:

$\text{L}_{eq,\text{day}}$ 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:

$\text{L}_{eq,\text{night}}$ is the nighttime equivalent sound level. The applicable time period is from 23:00 to 07:00 hours.

Point of Reception:


definition: 07:00 - 23:00 hours

Any outdoor point on residential property, 10 m or more from the nearest road's centreline, whose sound originating from the Line is received.

Nighttime: 23:00 - 07:00 hours

The plane of any bedroom window, 10 m or more from the nearest road’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, $\text{L}_{\text{pass}}$

Within the context of this document, the passby sound level is defined as the A-weighted equivalent sound level, $\text{L}_{eq}$ [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 vehicles between stations, the movement and unloading of vehicles inside stations as well as the movement of vehicles between the mainline and auxiliary facilities. Auxiliary facilities are not considered part of the rail transit and are assessed as stationary sources. Vehicles loading in maintenance yards and storage facilities are part of the stationary source.
3.0. ANNUAL FACILITIES

Predicted noise impacts from auxiliary facilities shall be assessed during the design of the Line, in accordance with the stationary source guidelines detailed in Reference 6. The predictions used shall be compatible with and at least as accurate as CSA Standard Z237,4A.

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's 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 module.

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.

6.0. GROUND-BORNE VIBRATION

The assessment of ground-borne vibration impact is concerned with 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 in the outside provisions. Structural characteristics of buildings are beyond the scope of this protocol and beyond the scope of the TTC.

It is recognized that ground-borne vibration can produce underground noise inside a structure and there is a direct correlation between the two. If 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 as a point of assessment using the limit in Section 6.0, Vibration Assessment.

1.0. DEFINITIONS

The following definitions are to be used only within the context of Part 6 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 centreline, where vibration originating from the Line is received.

Vibration Velocity:

Vibration velocity is the root-mean-square (r.m.s) vibration velocity measured during a vehicle pass-by. The unit of measure is meters per second (m/s) or millimeters per second (mm/s). For the purposes of this protocol only vertical vibration is assessed. The vertical component of train 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.

9.0. VIBRATION ASSESSMENT

Vibration velocities at points of assessment shall be predicted during design of the Line. If the predicted real vertical vibration velocity from the Line exceeds 0.2 mm/s, mitigation methods shall be applied during the detailed design to meet this criterion to the extent technologically, economically, and administratively feasible.

Any impact assessments 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 MOE.
Construction Equipment

1. **Scope**

   This Publication sets sound emission standards for various items of new construction equipment according to the date of manufacture of the equipment.

2. **Technical Definitions**

   The technical terms used in this Publication are defined in Publication NPC101 Technical Definitions.

3. **Sound Emission Standards**

   Tables 115-1 to 115-4 inclusive list Residential Area sound emission standards and Quiet Zone sound emission standards for specific items of new construction equipment measured in accordance with the procedures indicated.

**TABLE 115-1**

Quiet Zone and Residential Area Sound Emission Standards for Excavation Equipment, Dozers, Loaders, Backhoes or Other Equipment Capable of Being Used for Similar Application

<table>
<thead>
<tr>
<th>Date of Manufacture</th>
<th>Power Rating Less than 75 kW</th>
<th>Power Rating 75 kW and Larger</th>
</tr>
</thead>
<tbody>
<tr>
<td>January 1, 1979 to December 31, 1980</td>
<td>85</td>
<td>88</td>
</tr>
<tr>
<td>January 1, 1981 and after</td>
<td>83</td>
<td>85</td>
</tr>
</tbody>
</table>

Maximum Sound Level (dBA) as determined using Publication NPC - 103 - Procedures, section 6
### TABLE 115-2

**Sound Emission Standards for Pneumatic Pavement Breakers**

<table>
<thead>
<tr>
<th>Standard</th>
<th>Date of Manufacture</th>
<th>Maximum Sound Level (dBA) as measured using Publication NPC-103</th>
</tr>
</thead>
<tbody>
<tr>
<td>Quiet Zone Sound Emission Standard</td>
<td>January 1, 1979 and after</td>
<td>85</td>
</tr>
<tr>
<td>Residential Area Sound Emission Standard</td>
<td>January 1, 1979 to December 31, 1980</td>
<td>90</td>
</tr>
<tr>
<td></td>
<td>January 1, 1981 and after</td>
<td>85</td>
</tr>
</tbody>
</table>

### TABLE 115-3

**Sound Emission Standards for Portable Air Compressors**

<table>
<thead>
<tr>
<th>Standard</th>
<th>Date of Manufacture</th>
<th>Maximum Sound Level (dBA) as measured using Publication NPC-103</th>
</tr>
</thead>
<tbody>
<tr>
<td>Quiet Zone Sound Emission Standard</td>
<td>January 1, 1979 to December 31, 1980</td>
<td>76</td>
</tr>
<tr>
<td></td>
<td>January 1, 1981 and after</td>
<td>70</td>
</tr>
<tr>
<td>Residential Area Sound Emission Standard</td>
<td>January 1, 1979 and after</td>
<td>76</td>
</tr>
</tbody>
</table>
# NPC-115

## TABLE 115-4

### Sound Emission Standard for Tracked Drills

<table>
<thead>
<tr>
<th>Standard</th>
<th>Date of Manufacture</th>
<th>Maximum Sound Level (dBA) as measured using Publication NPC - 103 Procedures, section 6</th>
</tr>
</thead>
<tbody>
<tr>
<td>Quiet Zone and Residential Area Sound Emission Standard</td>
<td>January 1, 1981 and after</td>
<td>100</td>
</tr>
</tbody>
</table>
APPENDIX C: REFERENCES


11. The Corporation of the City of Waterloo, By-law Number 2010-073, passed May 17, 2010.


APPENDIX D: DEFINITIONS

1 dB CHANGE (Noise)

For sounds experienced by a listener, one immediately following the other, a 1 dB change is the smallest increment which can be reliably detected by most people. If the time delay between experiencing the sounds is more than a few seconds, the change is not reliably detected (i.e., the listener is not sensitive to a 1 dB change occurring over 1 year's time). In environmental noise, a 1 dB change occurs with an increase in traffic of 25%.

3 dB CHANGE (Noise)

An increase in the $L_{eq}$ of 3 dB is reliably detected by most listeners, and is the smallest change considered significant by most planning authorities. It is the smallest change in the overall $L_{eq}$ (all sounds combined) which can be reliably detected by standard noise monitoring techniques. A doubling of traffic in a community will cause a 3 dB change, if traffic is the only major noise source.

5 dB CHANGE (Noise)

An increase in the overall $L_{eq}$ of 5 dB represents a relatively significant impact in terms of overall $L_{eq}$, particularly if an area is already at or above daytime $L_{eq}$ of 55.

10 dB CHANGE (Noise)

A 10 dB increase in overall $L_{eq}$ represents a doubling in the loudness of the sound, and represents a major impact on an urban community, especially if the levels are already above 50 $L_{eq}$.

$Leq$

$L_{eq}$ is the sound pressure level averaged over the measurement period. It can be considered as the continuous steady sound pressure level that would have the same total acoustic energy as the real fluctuating noise over the same time period. This index is the most representative measure of community response to sound levels.

Ground-borne Vibration

Ground-borne vibration is vibration transmitted through the soil that is felt, rather than heard. Typically, vibration levels are most felt at frequencies below 50Hz.

Vibration-induced Noise

Vibration-induced noise is a result of ground-borne vibration being transmitted into the structure of a building and radiating as a “rumbly” sound that is more audible than “feelable” to the touch. Generally, vibration-induced noise is a concern at frequencies greater than 50Hz.

Vibration Velocity

Vibration velocity is the speed at which the building or ground moves up and down or sideways.
as it oscillates. It is does not relate to how fast the vibration wave is moving along in the soil.

**Double Crossover**

A type of special trackwork structure that allows a rail vehicle to switch directions, without the need for a loop.

**Double-ended Pocket Track**

A type of special trackwork structure that allows a vehicle to be stored in between two tracks in case of emergencies/vehicle breakdown.
APPENDIX E: SOUND LEVEL MEASUREMENT DETAILS
APPENDIX F: SAMPLE CALCULATIONS
Examples of Sound Levels During Passby of Several Individual Vehicles

Average or Mean of Maximum or Peak of "Fast" response Sound Levels of the Passbys. This is the value used in ORNAMENT and LRT noise calculations.
VOLUMES INCREASED x5

Road data, segment # 1: (day/night)

<table>
<thead>
<tr>
<th>Car traffic volume</th>
<th>0/0 veh/TimePeriod</th>
</tr>
</thead>
<tbody>
<tr>
<td>Medium truck volume</td>
<td>2440/320 veh/TimePeriod</td>
</tr>
<tr>
<td>Heavy truck volume</td>
<td>0/0 veh/TimePeriod</td>
</tr>
<tr>
<td>Posted speed limit</td>
<td>60 km/h</td>
</tr>
<tr>
<td>Road gradient</td>
<td>0 %</td>
</tr>
<tr>
<td>Road pavement</td>
<td>1 (Typical asphalt or concrete)</td>
</tr>
</tbody>
</table>

Data for Segment # 1: (day/night)

<table>
<thead>
<tr>
<th>Angle1 Angle2</th>
<th>-90.00 deg 90.00 deg</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wood depth</td>
<td>0 (No woods.)</td>
</tr>
<tr>
<td>No of house rows</td>
<td>0 / 0</td>
</tr>
<tr>
<td>Surface</td>
<td>2 (Reflective ground surface)</td>
</tr>
<tr>
<td>Receiver source distance</td>
<td>18.00 / 18.00 m</td>
</tr>
<tr>
<td>Receiver height</td>
<td>1.50 / 4.50 m</td>
</tr>
<tr>
<td>Topography</td>
<td>1 (Flat/gentle slope; no barrier)</td>
</tr>
<tr>
<td>Reference angle</td>
<td>0.00</td>
</tr>
</tbody>
</table>

Results segment # 1: (day)

Source height = 0.50 m

ROAD (0.00 + 66.70 + 0.00) = 66.70 dBA

<table>
<thead>
<tr>
<th>-90 90 0.00 67.49 0.00 -0.79 0.00 0.00 0.00 0.00 66.70</th>
</tr>
</thead>
</table>

Segment Leq : 66.70 dBA

Total Leq All Segments: 66.70 dBA

Results segment # 1: (night)

Source height = 0.50 m

ROAD (0.00 + 60.89 + 0.00) = 60.89 dBA

<table>
<thead>
<tr>
<th>-90 90 0.00 61.68 0.00 -0.79 0.00 0.00 0.00 0.00 60.89</th>
</tr>
</thead>
</table>

Segment Leq : 60.89 dBA

Total Leq All Segments: 60.89 dBA

TOTAL Leq FROM ALL SOURCES (DAY): 66.70
(NIGHT): 60.89
DISTANCED DOUBLED, LRT VOLUME INCREASED x10

Road data, segment # 1:  (day/night)

Car traffic volume :  0/0    veh/TimePeriod
Medium truck volume :  2440/320   veh/TimePeriod
Heavy truck volume :  0/0      veh/TimePeriod
Posted speed limit :  40 km/h
Road gradient :  0 %
Road pavement :  1 (Typical asphalt or concrete)

Data for Segment # 1:  (day/night)

Angle1 Angle2 : -90.00 deg   90.00 deg
Wood depth :      0       (No woods.)
No of house rows :  0 / 0
Surface :        2       (Reflective ground surface)
Receiver source distance :  16.00 / 16.00  m
Receiver height :   1.50 / 4.50   m
Topography :      1       (Flat/gentle slope; no barrier)
Reference angle :  0.00

Results segment # 1:  (day)

Source height = 0.50 m
ROAD (0.00 + 63.00 + 0.00) = 63.00 dBA

<table>
<thead>
<tr>
<th>Angle1</th>
<th>Angle2</th>
<th>Alpha</th>
<th>RefLeq</th>
<th>P.Adj</th>
<th>D.Adj</th>
<th>F.Adj</th>
<th>W.Adj</th>
<th>H.Adj</th>
<th>B.Adj</th>
<th>SubLeq</th>
</tr>
</thead>
<tbody>
<tr>
<td>-90</td>
<td>90</td>
<td>0.00</td>
<td>63.28</td>
<td>0.00</td>
<td>-0.28</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>63.00</td>
</tr>
</tbody>
</table>

Segment Leq : 63.00 dBA
Total Leq All Segments: 63.00 dBA

Results segment # 1:  (night)

Source height = 0.50 m
ROAD (0.00 + 57.19 + 0.00) = 57.19 dBA

<table>
<thead>
<tr>
<th>Angle1</th>
<th>Angle2</th>
<th>Alpha</th>
<th>RefLeq</th>
<th>P.Adj</th>
<th>D.Adj</th>
<th>F.Adj</th>
<th>W.Adj</th>
<th>H.Adj</th>
<th>B.Adj</th>
<th>SubLeq</th>
</tr>
</thead>
<tbody>
<tr>
<td>-90</td>
<td>90</td>
<td>0.00</td>
<td>57.47</td>
<td>0.00</td>
<td>-0.28</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>57.19</td>
</tr>
</tbody>
</table>

Segment Leq : 57.19 dBA
Total Leq All Segments: 57.19 dBA

TOTAL Leq FROM ALL SOURCES (DAY): 63.00
(NIGHT): 57.19
DISTANCES DOUBLED

Road data, segment # 1: (day/night)
-------------------------------------
- Car traffic volume : 11473/2350 veh/TimePeriod
- Medium truck volume : 483/99 veh/TimePeriod
- Heavy truck volume : 121/25 veh/TimePeriod
- Posted speed limit : 50 km/h
- Road gradient : 0 %
- Road pavement : 1 (Typical asphalt or concrete)

Data for Segment # 1: (day/night)
----------------------------------
- Angle1 Angle2 : -90.00 deg 90.00 deg
- Wood depth : 0 (No woods.)
- No of house rows : 0 / 0
- Surface : 2 (Reflective ground surface)
- Receiver source distance : 28.00 / 28.00 m
- Receiver height : 1.50 / 4.50 m
- Topography : 1 (Flat/gentle slope; no barrier)
- Reference angle : 0.00

Results segment # 1: (day)
----------------------------
Source height = 1.00 m
ROAD (0.00 + 61.52 + 0.00) = 61.52 dBA

<table>
<thead>
<tr>
<th>Angle1</th>
<th>Angle2</th>
<th>Alpha</th>
<th>RefLeq</th>
<th>P.Adj</th>
<th>D.Adj</th>
<th>F.Adj</th>
<th>W.Adj</th>
<th>H.Adj</th>
<th>B.Adj</th>
<th>SubLeq</th>
</tr>
</thead>
<tbody>
<tr>
<td>-90</td>
<td>90</td>
<td>0.00</td>
<td>64.23</td>
<td>0.00</td>
<td>-2.71</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>61.52</td>
</tr>
</tbody>
</table>

Segment Leq : 61.52 dBA
Total Leq All Segments: 61.52 dBA

Results segment # 1: (night)
-----------------------------
Source height = 1.00 m
ROAD (0.00 + 57.66 + 0.00) = 57.66 dBA

<table>
<thead>
<tr>
<th>Angle1</th>
<th>Angle2</th>
<th>Alpha</th>
<th>RefLeq</th>
<th>P.Adj</th>
<th>D.Adj</th>
<th>F.Adj</th>
<th>W.Adj</th>
<th>H.Adj</th>
<th>B.Adj</th>
<th>SubLeq</th>
</tr>
</thead>
<tbody>
<tr>
<td>-90</td>
<td>90</td>
<td>0.00</td>
<td>60.37</td>
<td>0.00</td>
<td>-2.71</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>57.66</td>
</tr>
</tbody>
</table>

Segment Leq : 57.66 dBA
Total Leq All Segments: 57.66 dBA

TOTAL Leq FROM ALL SOURCES (DAY): 61.52
(NIGHT): 57.66
DISTANCES DOUBLED

Road data, segment # 1: (day/night)

<table>
<thead>
<tr>
<th>Car traffic volume</th>
<th>Medium truck volume</th>
<th>Heavy truck volume</th>
<th>Posted speed limit</th>
<th>Road gradient</th>
<th>Road pavement</th>
</tr>
</thead>
<tbody>
<tr>
<td>14690/3009 veh/TimePeriod</td>
<td>619/127 veh/TimePeriod</td>
<td>155/32 veh/TimePeriod</td>
<td>50 km/h</td>
<td>0 %</td>
<td>1 (Typical asphalt or concrete)</td>
</tr>
</tbody>
</table>

Data for Segment # 1: (day/night)

<table>
<thead>
<tr>
<th>Angle1</th>
<th>Angle2</th>
<th>Alpha</th>
<th>RefLeq</th>
<th>P.Adj</th>
<th>D.Adj</th>
<th>F.Adj</th>
<th>W.Adj</th>
<th>H.Adj</th>
<th>B.Adj</th>
<th>SubLeq</th>
</tr>
</thead>
<tbody>
<tr>
<td>-90</td>
<td>90</td>
<td>0.00</td>
<td>65.31</td>
<td>0.00</td>
<td>-2.71</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>62.60</td>
</tr>
</tbody>
</table>

Segment Leq: 62.60 dBA

Total Leq All Segments: 62.60 dBA

Results segment # 1: (night)

Source height = 1.00 m

ROAD (0.00 + 58.73 + 0.00) = 58.73 dBA

<table>
<thead>
<tr>
<th>Angle1</th>
<th>Angle2</th>
<th>Alpha</th>
<th>RefLeq</th>
<th>P.Adj</th>
<th>D.Adj</th>
<th>F.Adj</th>
<th>W.Adj</th>
<th>H.Adj</th>
<th>B.Adj</th>
<th>SubLeq</th>
</tr>
</thead>
<tbody>
<tr>
<td>-90</td>
<td>90</td>
<td>0.00</td>
<td>61.44</td>
<td>0.00</td>
<td>-2.71</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>58.73</td>
</tr>
</tbody>
</table>

Segment Leq: 58.73 dBA

Total Leq All Segments: 58.73 dBA

TOTAL Leq FROM ALL SOURCES (DAY): 62.60
(NIGHT): 58.73
DISTANCED DOUBLED, LRT VOLUME INCREASED x5

Road data, segment # 1: (day/night)

Car traffic volume : 0/0 veh/TimePeriod
Medium truck volume : 2440/320 veh/TimePeriod
Heavy truck volume : 0/0 veh/TimePeriod
Posted speed limit : 40 km/h
Road gradient : 0 %
Road pavement : 1 (Typical asphalt or concrete)

Data for Segment # 1: (day/night)

Angle1 Angle2 : -90.00 deg  90.00 deg
Wood depth : 0 (No woods.)
No of house rows : 0 / 0
Surface : 2 (Reflective ground surface)
Receiver source distance : 24.00 / 24.00 m
Receiver height : 1.50 / 4.50 m
Topography : 1 (Flat/gentle slope; no barrier)
Reference angle : 0.00

Results segment # 1: (day)

Source height = 0.50 m
ROAD (0.00 + 61.24 + 0.00) = 61.24 dBA

<table>
<thead>
<tr>
<th>Angle1</th>
<th>Angle2</th>
<th>Alpha</th>
<th>RefLeq</th>
<th>P.Adj</th>
<th>D.Adj</th>
<th>F.Adj</th>
<th>W.Adj</th>
<th>H.Adj</th>
<th>B.Adj</th>
<th>SubLeq</th>
</tr>
</thead>
<tbody>
<tr>
<td>-90</td>
<td>90</td>
<td>0.00</td>
<td>63.28</td>
<td>0.00</td>
<td>-2.04</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>61.24</td>
</tr>
</tbody>
</table>

Segment Leq : 61.24 dBA
Total Leq All Segments: 61.24 dBA

Results segment # 1: (night)

Source height = 0.50 m
ROAD (0.00 + 55.43 + 0.00) = 55.43 dBA

<table>
<thead>
<tr>
<th>Angle1</th>
<th>Angle2</th>
<th>Alpha</th>
<th>RefLeq</th>
<th>P.Adj</th>
<th>D.Adj</th>
<th>F.Adj</th>
<th>W.Adj</th>
<th>H.Adj</th>
<th>B.Adj</th>
<th>SubLeq</th>
</tr>
</thead>
<tbody>
<tr>
<td>-90</td>
<td>90</td>
<td>0.00</td>
<td>57.47</td>
<td>0.00</td>
<td>-2.04</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>55.43</td>
</tr>
</tbody>
</table>

Segment Leq : 55.43 dBA
Total Leq All Segments: 55.43 dBA

TOTAL Leq FROM ALL SOURCES (DAY): 61.24
 (NIGHT): 55.43
DISTANCES DOUBLED

Road data, segment # 1: (day/night)
------------------------------------
Car traffic volume : 19713/4038 veh/TimePeriod
Medium truck volume : 830/170 veh/TimePeriod
Heavy truck volume : 208/43 veh/TimePeriod
Posted speed limit :  50 km/h
Road gradient : 0 %
Road pavement : 1 (Typical asphalt or concrete)

Data for Segment # 1: (day/night)
----------------------------------
Angle1   Angle2           : -90.00 deg   90.00 deg
Wood depth                :      0       (No woods.)
No of house rows          :      0 / 0
Surface                   :      2       (Reflective ground surface)
Receiver source distance  : 24.00 / 24.00  m
Receiver height           :   1.50 / 4.50   m
Topography                :      1       (Flat/gentle slope; no barrier)
Reference angle           :   0.00

Results segment # 1: (day)
---------------------------
Source height = 1.00 m
ROAD (0.00 + 64.54 + 0.00) = 64.54 dBA

| Angle1 Angle2 Alpha RefLeq P.Adj D.Adj F.Adj W.Adj H.Adj B.Adj SubLeq |
|-------------------------|---------|-----------------|-------|-------|-------|-------|-------|-------|-------|---------|
| -90                     90       0.00   66.58   0.00   -2.04   0.00   0.00   0.00   0.00   64.54 |

Segment Leq : 64.54 dBA
Total Leq All Segments: 64.54 dBA

Results segment # 1: (night)
---------------------------
Source height = 1.00 m
ROAD (0.00 + 60.68 + 0.00) = 60.68 dBA

| Angle1 Angle2 Alpha RefLeq P.Adj D.Adj F.Adj W.Adj H.Adj B.Adj SubLeq |
|-------------------------|---------|-----------------|-------|-------|-------|-------|-------|-------|-------|---------|
| -90                     90       0.00   62.72   0.00   -2.04   0.00   0.00   0.00   0.00   60.68 |

Segment Leq : 60.68 dBA
Total Leq All Segments: 60.68 dBA

TOTAL Leq FROM ALL SOURCES (DAY): 64.54
(NIGHT): 60.68
MINISTRY OF ENVIRONMENT AND ENERGY / NOISE ASSESSMENT

Filename: wp.te    Time Period: Day/Night 16/8 hours
Description: POR12 With Project Traffic Only

DISTANCES DOUBLED

Road data, segment # 1: (day/night)
---------------------------------------
Car traffic volume : 14666/3004 veh/TimePeriod
Medium truck volume :  618/126  veh/TimePeriod
Heavy truck volume  :  154/32   veh/TimePeriod
Posted speed limit :  50 km/h
Road gradient : 0 %
Road pavement : 1 (Typical asphalt or concrete)

Data for Segment # 1: (day/night)
---------------------------------
Angle1 Angle2           : -90.00 deg   90.00 deg
Wood depth                :      0       (No woods.)
No of house rows          :      0 / 0
Surface                   :      2       (Reflective ground surface)
Receiver source distance  :  22.00 / 22.00  m
Receiver height           :   1.50 / 4.50   m
Topography                :      1       (Flat/gentle slope; no barrier)
Reference angle           :   0.00

Results segment # 1: (day)
---------------------------
Source height = 1.00 m
ROAD (0.00 + 63.63 + 0.00) = 63.63 dBA

<table>
<thead>
<tr>
<th>Angle1</th>
<th>Angle2</th>
<th>Alpha</th>
<th>RefLeq</th>
<th>P.Adj</th>
<th>D.Adj</th>
<th>F.Adj</th>
<th>W.Adj</th>
<th>H.Adj</th>
<th>B.Adj</th>
<th>SubLeq</th>
</tr>
</thead>
<tbody>
<tr>
<td>-90</td>
<td>90</td>
<td>0.00</td>
<td>65.29</td>
<td>0.00</td>
<td>-1.66</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>63.63</td>
</tr>
</tbody>
</table>

Segment Leq : 63.63 dBA
Total Leq All Segments: 63.63 dBA

Results segment # 1: (night)
---------------------------
Source height = 1.00 m
ROAD (0.00 + 59.77 + 0.00) = 59.77 dBA

<table>
<thead>
<tr>
<th>Angle1</th>
<th>Angle2</th>
<th>Alpha</th>
<th>RefLeq</th>
<th>P.Adj</th>
<th>D.Adj</th>
<th>F.Adj</th>
<th>W.Adj</th>
<th>H.Adj</th>
<th>B.Adj</th>
<th>SubLeq</th>
</tr>
</thead>
<tbody>
<tr>
<td>-90</td>
<td>90</td>
<td>0.00</td>
<td>61.43</td>
<td>0.00</td>
<td>-1.66</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>59.77</td>
</tr>
</tbody>
</table>

Segment Leq : 59.77 dBA
Total Leq All Segments: 59.77 dBA

TOTAL Leq FROM ALL SOURCES (DAY): 63.63
(NIGHT): 59.77
DISTANCES DOUBLED

Road data, segment # 1:  (day/night)
------------------------------------
Car traffic volume  : 11749/2406 veh/TimePeriod
Medium truck volume :   495/101 veh/TimePeriod
Heavy truck volume  :   124/25 veh/TimePeriod
Posted speed limit  :    50 km/h
Road gradient       :     0 %
Road pavement       :     1 (Typical asphalt or concrete)

Data for Segment # 1:  (day/night)
----------------------------------
Angle1   Angle2           : -90.00 deg   90.00 deg
Wood depth                :      0       (No woods.)
No of house rows          :      0 / 0
Surface                   :      2       (Reflective ground surface)
Receiver source distance  :  20.00 / 20.00  m
Receiver height           :   1.50 / 4.50   m
Topography                :      1       (Flat/gentle slope; no barrier)
Reference angle           :   0.00

Results segment # 1:  (day)
---------------------------
Source height = 1.00 m
ROAD (0.00 + 63.09 + 0.00) = 63.09 dBA

<table>
<thead>
<tr>
<th>Angle1</th>
<th>Angle2</th>
<th>Alpha</th>
<th>RefLeq</th>
<th>P.Adj</th>
<th>D.Adj</th>
<th>F.Adj</th>
<th>W.Adj</th>
<th>H.Adj</th>
<th>B.Adj</th>
<th>SubLeq</th>
</tr>
</thead>
<tbody>
<tr>
<td>-90</td>
<td>90</td>
<td>0.00</td>
<td>64.34</td>
<td>0.00</td>
<td>-1.25</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>63.09</td>
</tr>
</tbody>
</table>

Segment Leq : 63.09 dBA
Total Leq All Segments: 63.09 dBA

Results segment # 1:  (night)
---------------------------
Source height = 1.00 m
ROAD (0.00 + 59.19 + 0.00) = 59.19 dBA

<table>
<thead>
<tr>
<th>Angle1</th>
<th>Angle2</th>
<th>Alpha</th>
<th>RefLeq</th>
<th>P.Adj</th>
<th>D.Adj</th>
<th>F.Adj</th>
<th>W.Adj</th>
<th>H.Adj</th>
<th>B.Adj</th>
<th>SubLeq</th>
</tr>
</thead>
<tbody>
<tr>
<td>-90</td>
<td>90</td>
<td>0.00</td>
<td>60.44</td>
<td>0.00</td>
<td>-1.25</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>59.19</td>
</tr>
</tbody>
</table>

Segment Leq : 59.19 dBA
Total Leq All Segments: 59.19 dBA

TOTAL Leq FROM ALL SOURCES (DAY): 63.09
(NIGHT): 59.19
DISTANCES DOUBLED

Road data, segment # 1: (day/night)
---------------------------------------------
Car traffic volume : 8781/1816 veh/TimePeriod
Medium truck volume : 699/125 veh/TimePeriod
Heavy truck volume : 124/25 veh/TimePeriod
Posted speed limit : 50 km/h
Road gradient : 0 %
Road pavement : 1 (Typical asphalt or concrete)

Data for Segment # 1: (day/night)
----------------------------------
Angle1   Angle2           : -90.00 deg   90.00 deg
Wood depth                : 0          (No woods.)
No of house rows          : 0 / 0
Surface                   : 2          (Reflective ground surface)
Receiver source distance  : 20.00 / 20.00 m
Receiver height           : 1.50 / 4.50 m
Topography                : 1          (Flat/gentle slope; no barrier)
Reference angle           : 0.00

Results segment # 1: (day)
---------------------------
Source height = 1.07 m
ROAD (0.00 + 63.09 + 0.00) = 63.09 dBA

<table>
<thead>
<tr>
<th>Angle1</th>
<th>Angle2</th>
<th>Alpha</th>
<th>RefLeq</th>
<th>P.Adj</th>
<th>D.Adj</th>
<th>F.Adj</th>
<th>W.Adj</th>
<th>H.Adj</th>
<th>B.Adj</th>
<th>SubLeq</th>
</tr>
</thead>
<tbody>
<tr>
<td>-90</td>
<td>90</td>
<td>0.00</td>
<td>64.34</td>
<td>0.00</td>
<td>-1.25</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>63.09</td>
</tr>
</tbody>
</table>

Segment Leq : 63.09 dBA
Total Leq All Segments: 63.09 dBA

Results segment # 1: (night)
---------------------------
Source height = 1.06 m
ROAD (0.00 + 58.99 + 0.00) = 58.99 dBA

<table>
<thead>
<tr>
<th>Angle1</th>
<th>Angle2</th>
<th>Alpha</th>
<th>RefLeq</th>
<th>P.Adj</th>
<th>D.Adj</th>
<th>F.Adj</th>
<th>W.Adj</th>
<th>H.Adj</th>
<th>B.Adj</th>
<th>SubLeq</th>
</tr>
</thead>
<tbody>
<tr>
<td>-90</td>
<td>90</td>
<td>0.00</td>
<td>60.24</td>
<td>0.00</td>
<td>-1.25</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>58.99</td>
</tr>
</tbody>
</table>

Segment Leq : 58.99 dBA
Total Leq All Segments: 58.99 dBA

TOTAL Leq FROM ALL SOURCES (DAY): 63.09
(NIGHT): 58.99