APPENDIX C
Noise Analysis

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REPORT NO. WA07-090

ENVIRONMENTAL NOISE STUDY
MISSISSAUGA BUS RAPID TRANSIT (BRT) SYSTEM
BRT WEST – WINSTON CHURCHILL BOULEVARD TO ERIN MILLS PARKWAY
CITY OF MISSISSAUGA

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EXECUTIVE SUMMARY

This study has been carried out to investigate the potential noise impact of the proposed Mississauga Bus Rapid Transitway (BRT) West from Winston Churchill Boulevard to Erin Mills Parkway on the adjacent/nearby noise sensitive areas. The study dealt with the existing and future ambient as well as the future with the undertaking sound levels and their impact on the noise sensitive receptors.

The applicable sound level criteria are based on the Ministry of the Environment (MOE), Ministry of Transportation (MTO), Region of Peel and City of Mississauga noise guidelines and policies for transportation and stationary sources of noise.

Twenty two receptor locations were selected to represent the receptors (residences) within the study area. Calculations for the busway were based on a Leq 16 hour daytime descriptor (i.e. 07:00-23:00) and a Leq 8 hour nighttime descriptor (i.e. 23:00-07:00). Calculations for the stations were based on a Leq 1 hour descriptor for day (i.e. 07:00 – 10:00), evening (i.e. 19:00 – 20:00) and night (i.e. 06:00-07:00) The day, evening and night hours used for stations noise assessment were selected to represent the peak (i.e. worst-case) operational hours of the stations.

The daytime ambient sound levels (levels without the busway) are predicted to be in the range of 50 to 66dBA for the existing conditions and in the range of 51 to 67dBA for the future conditions.

The daytime future sound levels associated with the Busway are predicted to be in the range of 41 to 57 dBA, while the future sound levels associated with the BRT stations are predicted to be in the range of 54 to 62 dBA day, 52 to 59 dBA evening and 49 to 56 dBA night.

Attended and unattended sound level measurements were taken at typical receptors (residences) in the study area. The measured daytime ambient sound levels are in the range of 55 to 65 dBA, while the measured nighttime sound levels are in the range of 53 to 62 dBA. The measured hourly ambient sound levels are in the range of 64 dBA day, 60 to 63 dBA evening and 64 to 65 dBA night.

The excesses of the measured daytime ambient sound levels over the corresponding predicted sound levels are in the range of 1 to 3dBA, which are considered to be acoustically insignificant and are attributed to variations between the measured and modeled road traffic volumes and compositions and to the presence of exterior sources of noise that were not part of the prediction model. Based on this, the use of the predicted sound levels was deemed to yield consistent and reasonable results for the purpose of this study.

Based on the MOE sound level criteria, all the noise sensitive areas are

predicted to have insignificant or noticeable noise impacts (in the range of 1 to 3 dBA) and accordingly, there is no need to consider the application of noise control measures as the predicted increase is less than 5 dBA.

Accordingly, the results of this investigation and the recommendations in this study do not recommend that noise control measures be installed anywhere within the study area as a result of bus operations within the BRT system.

In accordance with an MOE Condition of Approval for the EA Addendum, commitments are made with regards to noise monitoring timing, locations, duration, MOE governing guidelines, report contents and submittal, as well as noise mitigation, if warranted.

With respect to construction noise, the closest residences are identified to be along Colombo Crescent and Radisson Crescent. Typical construction equipment sound levels are provided along with several recommended noise mitigation measures to mitigate the adverse noise effects during construction. The latter include restricting noisy activities to daytime hours, adherence to City's Noise By-Law, implementation of control procedures during construction and the inclusion of special provisions in the contract documents.

Mitigation measures are also recommended to control noise levels due to maintenance activities, which include restricting noisy activities to daytime hours, adhering to the City's Noise Control By-law and seeking and obtaining exemptions as warranted.

1.0 INTRODUCTION

The services of SS Wilson Associates were retained by the Consulting Engineering firm, McCormick Rankin Corp. to prepare an Environmental Noise Study for the Mississauga Bus Rapid Transit (Mississauga BRT).

Mississauga's Rapid Transit program is centered on the Mississauga Bus Rapid Transit (Mississauga BRT) facility, a busway running across the heart of the City. The project is now getting underway, courtesy of funding from the federal, provincial, and municipal governments. The Preliminary Design of the facility is currently being undertaken and construction is scheduled to be completed by 2013.

The Mississauga BRT facility was planned and approved under the *Ontario Environmental Assessment Act* in the early 1990s, and an Environmental Assessment (EA) Addendum for an updated plan was approved in 2005. The EA and EA Addendum were reviewed and approved by the Ministry of the Environment (MOE) subject to some Conditions of Approval. Two of the Conditions of Approval required that additional noise assessment works be completed. The applicable Conditions of Approval are outlined below.

Given the requirements of the MOE Condition of Approvals, an updated noise assessment has been undertaken to identify potential effects, mitigation measures, and to develop a preliminary monitoring strategy to be refined during Detail Design and implemented during the construction and operations components of the project.

This report documents the updated noise assessment for the section of the BRT facility between Winston Churchill Boulevard and Erin Mills Parkway to the north of Highway 403. That section of the BRT is also known as "BRT West". This noise assessment has been completed for the recommended Preliminary Design. An updated noise assessment is also being completed for the section of the BRT facility between Hurontario Street and Renforth Drive running alongside Eastgate Parkway and Eglinton Avenue (BRT East). The BRT East noise analysis will be documented in a separate report.

The general location of the BRT West study area is shown in Figure 1.

The objectives of this study are to:

- Measure and predict the exiting ambient sound levels;
- Determine the potential changes to the existing ambient sound levels due to the undertaking;
- Assess the predicted changes in the noise environment and to recommend measures to mitigate and monitor noise effects as warranted and in accordance with the recommendations outlined in the 1991 noise report (ref. SS Wilson

Associates Noise Report No. W90-72 dated February 1, 1991) and commitments to future work as identified in the Environmental Assessment and Environmental Assessment Addendum.

A letter will be submitted to the Ministry of the Environment for their review and comment in support of compliance with the above-noted Conditions of Approval.

The Mississauga BRT is also subject to a Screening under the *Canadian Environmental Assessment Act*. In keeping with commitments made in the project-specific CEAA Screening Report, this report will also be submitted to Transport Canada for their review.

Condition of Approval of the EA Report (part of Condition #3)

As a Condition of Approval (part of Condition #3) to the EA Report, the MOE required that written confirmation be provided to indicate that the recommendations of the noise report prepared by S.S. Wilson in 1991 will be adhered to.

3. *Prior to commencement of construction and the completion of detailed construction design of a stage, the Corporation of the City of Mississauga shall supply to the Ministry of Environment and Energy's Director of Central Region for review and approval:*

   …

   - *A letter stating that all the recommendations contained in the S.S. Wilson and Associates Report, Environmental Noise Study, Proposed Mississauga Busway System, W90-72 (February 1, 1991) will be followed.*

Details regarding compliance with the recommendations from the previous noise report are outlined in Section 5.2 (Recommendations).

Condition of Approval of the EA Addendum Report

In response to the EA Addendum Report, the MOE recommended that following the design of the BRT the City should monitor noise levels in the Erin Mills Parkway area to ensure that noise levels are in keeping with Ministry of the Environment noise guidelines.

In the approved EA, the City committed to monitoring noise levels prior to and following Transitway operation near potentially effected residential sites. During the preparation of the Addendum, public concern was expressed regarding noise levels in the Erin Mills Parkway area. Although the City has demonstrated that any increase in noise falls within Ministry guidelines, it is recommended that the City continue to monitor noise levels after the design stage in the Erin Mills Parkway area to ensure that these levels are in keeping with the Ministry of the Environment noise guidelines.

This study represents a joint effort with the Consulting Engineering Firm, McCormick Rankin Corp., who provided the necessary traffic data and overall project direction.

2.0 GENERAL APPROACH AND PROJECT DESCRIPTION

2.1 General Approach

Road traffic (busway) sound levels have been predicted using the Ministry of the Environment (MOE) noise prediction model, ORNAMENT, which is based on the technique developed by the U.S. Federal Highway Administration (FHWA) and enhanced by the Ministry of Transportation and the Ministry of the Environment.

The STAMSON program Version 5.04 (2000) was used for calculating all road and bus traffic sound levels based on analysis of multiple road sections/segments to further enhance its three-dimensional capabilities. STAMSON is the computerized version of the MOE's current noise prediction model, ORNAMENT.

The road traffic sound level calculations are primarily based on the average daily traffic volumes (AADT), percentages of medium and heavy vehicles, posted speed limits, road to receptor distance, elevation differential between the road and the receptor, roadway gradient, pavement type and the type of ground cover between the road and the receptor in question.

Based on MOE guidelines for predicting road traffic noise, the equivalent daytime sound level in dBA, Leq corresponding to the average hourly volume of the 16 hours traffic (07:00-23:00) was used for noise impact assessment , i.e. Leq_{16} in dBA. For information purposes, the equivalent nighttime sound level in dBA, Leq_8 corresponding to the average hourly volume of the 8 hours traffic (23:00-07:00) was included in this study.

For BRT stations, stationary source assessment procedures were employed as was recommended by the MOE. The approach requires the assessment of hourly sound levels (i.e. Leq_{1h}).

Stationary sources sound levels assessed were predicted using an ISO-based prediction model developed by SS Wilson Associates. The stationary sound level calculations are based on reference sound emission levels of buses and cars, bus and car volumes, distance setbacks, acoustic shielding by barriers and other structures, ground and atmospheric attenuation, and grade elevations.

Noise measurements both short term (over a period of 4 hours) attended and long term (over a period of 5 days) unattended) were carried out to establish the sound emission levels of buses and cars and the prevailing ambient sound levels. The short term attended measurements were used in the stationary source prediction model, while the long term unattended measurements were used to verify the predicted ambient sound levels due to road traffic.

For the purpose of this study, the environmental noise impact assessment is based on the change in sound levels above the ambient sound levels.

2.2 Project Description

The BRT West system extends from Winston Churchill Boulevard to Erin Mills Parkway, north of Highway 403 and generally within the Hydro transmission corridor in the City of Mississauga.

BRT West will consists of two BRT stations (one at north-west corner of Highway 403 and Winston Churchill Boulevard and the other at the north-west corner of Highway 403 and Erin Mills Parkway) and a busway connecting the two stations. The busway is grade separated at the Winston Churchill Boulevard interchange and at Glen Erin Drive.

The busway will be an exclusive, grade separated, two lane, bus-only roadway with stations that allow for integration with local road bus services. The stations will include such infrastructure items as GO Transit and Mississauga BRT platforms, local bus platforms, passenger drop-off areas, passenger shelters, waiting areas, pedestrian overpasses, concrete safety barriers, fencing, where required, parking facilities and access roads, elevators, stairs, etc.

Plans and profiles pertaining to the existing and proposed project conditions have been supplied by McCormick Rankin Corp.

Road and bus traffic data pertaining to the existing and proposed project conditions have also been supplied by McCormick Rankin Corp.

Appendix A includes the traffic data used in this study.

3.0 SOUND LEVEL CRITERIA

3.1 MOE SOUND LEVEL CRITERIA FOR BUS MOVEMENTS

At the present time, there are no provincial regulations or policies for the control of individual or cumulative bus sound levels operating on provincial or municipal roadways.

The only applicable provincial legislation is the Highway Traffic Act which requires all vehicles to be equipped with exhaust muffling devices. On the other hand, the Federal Government has published noise emission standards for new buses not to exceed 83 dBA at 15m when tested at the manufacturer's facilities.

The following summarizes the MOE noise criteria endorsed for the City of Mississauga BRT system (ref. MOE letter dated November 29, 1990):

1. Bus Movements Between Stations

The noise should be assessed on a 16/8 hour basis, 07:00-23:00 and 23:00-07:00. The criteria should be 55 dBA, day-time and 50 dBA, night-time, or the ambient in either period, whichever is higher. Control measures need be applied only if the excess is more than 5 dBA.

2. Bus Stops

Simple bus stops do not have to be separated from the general noise produced by the moving buses.

3. Bus Stations

Bus stations are stationary sources and should be assessed in accordance with NPC-105 (now NPC-205). This implies assessment using 1 hour Leq and the limit being defined by the pre-existing ambient noise level.

3.2 MOE SOUND LEVEL CRITERIA FOR CONSTRUCTION EQUIPMENT

The Ministry of the Environment (MOE) Publications NPC-115 "Construction Equipment" and NPC-118, "Motorized Conveyances" deal with sound levels generated by construction equipment. These publications do not set overall combined sound level limits due to construction sites but set limits for noise generated by the individual pieces of equipment used on construction sites.

With respect to truck noise, the governing criteria are contained in the Federal Government safety test standards for manufacturing of new trucks included in their publication titled "SECTION 1106-Noise Emission Tests for Motor Vehicles,

and the relevant Consolidated Regulations of Canada, 1978 amended by SOP-179-115, September 1, 1979: Section 1106". Typical trucks maximum sound emission level is 83 dBA for a vehicle gross weight of over 4500 kg.

3.3 APPLICABLE SOUND LEVEL CRITERIA

The following sound level criteria apply to all vehicular and bus traffic within the BRT system:

- The applicable sound level descriptor is the A-Weighted Equivalent Sound Pressure Level, Leq in dBA established for the daytime period from 07:00 to 23:00, also referred to as Leq16 hr, dBA. Nighttime period from 23:00 to 07:00 assessment of the noise impact will not be considered.
- The objective for outdoor sound levels when applying mitigation measures is the higher of the Leq16 hr 55 dBA or the future do-nothing ambient. Mitigation will attempt to achieve sound levels as close to these levels as is administratively, economically and technically feasible.
- The significance of a noise impact, also referred to as the 'excess' or 'change' will be quantified by comparing the future sound levels with the higher of the Leq16 hr 55 dBA and/or the future do-nothing ambient. The excess or change of the future sound levels relative to the existing ambient must also be determined.
- The degree of effort applied, and action for mitigation of the noise impact should conform to Table 1.
- Where the future sound level exceeds Leq16 hr 55 dBA and the increase in the sound levels above the future do-nothing ambient exceeds 5 dBA, the feasibility of noise control measures within the right-of-way will be investigated. Appropriate measures will be introduced such that, where feasible, a minimum attenuation (averaged over the first row of receivers) of 5 dBA can be achieved.

Additional considerations that must be incorporated are outlined below:

- To define the area of noise impact from the BRT, the smallest study area should be defined using one or more of the following methods:
  - Using 5 dBA contour lines extending from the source to a noise sensitive area where there is no increase above the ambient sound level;
  - A noise sensitive area where there is no increase above the ambient sound level;
  - A perpendicular distance of 200 m from the closest edge of pavement.
- The noise impact on noise sensitive areas is to be determined for outdoor spaces.
- There is no minimum number of residences that define a noise sensitive area. Therefore, all noise sensitive land uses, regardless of size or location, are to be assessed for application of noise control measures.

- The existing ambient sound levels will be based on the existing road and traffic information at the time of project initiation (in this study the existing traffic was based on year 2007).
- Future do-nothing ambient is the sound level 10 years after construction (in this study the future-do-nothing traffic was based on year 2017) of a Busway if no action had been taken to improve transportation facilities.
- Future sound levels from the project will be based on traffic projections to the horizon years of the project (in this study the future BRT traffic was based on year 2021).
- Off right-of-way noise control measures will not be considered.
- Impact assessment ratings may be interpreted based on Table 1.
- The sound levels will be established using prediction models acceptable to the City of Mississauga and Province of Ontario.
- Consideration must be given to the noise impacts of moving traffic on the BRT busway as well as stationary noise sources such as equipment and bus/car operations within the BRT stations.

4.0 ANALYSIS AND RESULTS

4.1 AMBIENT/BACKGROUND NOISE

Ambient noise used in the context of this report is the sound levels at the selected receptor locations without the additional noise generated by the BRT West system.

The existing ambient/background sound levels are primarily due to vehicular traffic on the nearby highways/roadways in the area including Highway 403, the intersecting arterial roads and the associated ramps of Highway 403. The following is a list of the transportation sources of noise considered in this study:

- Highway 403
- Winston Churchill Boulevard
- Glen Erin Boulevard
- Erin Mills Parkway

It should be noted that there are other major sources of transportation noise affecting the area of concern which were not included in the estimation of the ambient noise. The sources include aircraft and railway noise which were specifically excluded from the analysis in order to comply with the MOE recommendation for the exclusion of sources of noise that are fairly intermittent in nature.

Ambient noise due to vehicular traffic movements on the above-noted highways/roadways were calculated using the MOE ORNAMENT noise prediction model {STAMSON Version 5.04 (2000)} based on the road traffic data supplied by McCormick Rankin Corp.

The predicted day and night (i.e. Leq(16h) and Leq(8h) ambient sound levels are listed in Table 4.1 (existing ambient) and Table 4.2 (future-do-nothing ambient), while the predicted hourly day, evening and night (i.e. Leq(1h)) ambient sound levels are listed in Table 4.3.

Appendix A contains the road traffic data used for the ambient noise calculations, while Appendix C includes sample ambient noise calculations.

4.2 POINTS OF RECEPTION

Points of reception are considered any point on the premises of a person where sounds originating from other than the premises are received.

For the purposes of this study, several representative locations were selected to

represent all the closest points of reception to both the busway and stations, which may potentially be affected by noise. The receptor heights were taken at Outdoor Living Areas (OLA's) when calculating the BRT busway sound levels and at typical second storey windows when calculating the BRT stations sound levels.

The following gives a brief description of the selected receptors (denoted Rw1 to Rw22):

Rw1: Townhouse #3475 Angel Pass Drive
Rw2 Townhouse #3448 Angel Pass Drive
Rw3 Townhouse #3146 Angel Pass Drive
Rw4 House #4756 Colombo Crescent
Rw5 House #4735 Colombo Crescent
Rw6 House #4748 Colombo Crescent
Rw7 House #2646 Ambercroft Trail
Rw8 House #4424 Romfield Crescent
Rw9 House #4368 Romfield Crescent
Rw10 House #4440 Idlewilde Crescent
Rw11 House #4418 Radisson Crescent
Rw12 House #4382 Radisson Crescent
Rw13 House #4354 Radisson Crescent
Rw14 House #4498 Hydock Park Drive
Rw15 House #4434 Sawmill Valley Drive
Rw16 House #4243 Trellis Crescent
Rw17 House #2549 Folkway Drive
Rw18 House #4424 Treetop Court
Rw19 House #4367 Treetop Court
Rw20 House #4279 Thom Gardens
Rw21 House #2850 Remea Court
Rw22 House #2934 Remea Court

Figures 2.1 to 2.7 show the locations of the selected receptors.

Photographs 1 to 18 show different views of the study area residences and surroundings.

4.3 DESCRIPTION OF THE NOISE SOURCES

The primary sources of noise associated with the BRT system are bus movements on the busway and bus activities within the stations. Other sources of noise of lesser magnitude include automobile traffic using the designated parking areas associated with the stations and possibly mechanical equipment associated with the stations. The noise emitted by buses is due to bus exhaust, engine and tire/ground interaction depending on the bus speed and the type of pavement.

Since noise prediction methodologies for buses moving on a roadway or within a station are different, the description of the specific bus activities and associated sound levels will be dealt with separately.

1. In-Between Stations

At Ground Level

Buses are expected to operate between stations at up to 90 km/h, except near the stations where buses will be accelerating and decelerating.

The traffic noise prediction model used for the assessment of bus movements between the stations is the MOE noise prediction model "ORNAMENT" {STAMSON Version 5.04(2000)}.

For this analysis, no other sources of noise were considered along the busway since buses are the predominant part of vehicular traffic allowed within the BRT system corridor.

In Cut Sections

For bus movements along the BRT busway in a retained (i.e. below grade) cut where the right-of-way is restricted (a typical section is shown in Figure 3), sound waves reflect back and forth across the alignment one or more times before ultimately progressing outwards towards nearby receptors. These multiple reflections have the potential to increase the sound levels at certain points of reception, depending on the geometry of the situation.

While cut sections, in general, are sometimes considered as sound barriers as a result of their ability to diffract the sound waves around their edge(s), the added reflected sound waves create a reverberant sound field thus resulting in higher sound levels which may offset the noise reduction due to the sound barrier effect created by the cut section.

For receptors further away from deep cuts, the net result is minor reduction in the sound levels and for shallower cuts, the net result is minor increase in the sound levels. For close-by receptors, the net result is a noticeable increase in the sound levels for both shallower and deep cuts.

For elevated receptor locations, near and far, the net result is always a noticeable increase (in the order of 4 to 6 dBA) in the sound levels in addition to prolonged exposure to the noise signal and the possible change of the character of noise to be that of an echo.

The foregoing conclusions are based on the assumption that the surfaces of

the cut section are hard reflecting such as with the use of concrete and asphalt with nearly vertical side walls.

2. Within the Stations

The primary sources of noise within a bus station are due to a variety of bus activities and movements within the designated areas of the stations where buses accelerate, decelerate, idle and move at constant speeds. Such activities generate different sound levels and the time or duration of each event varies. Since the ORNAMENT model cannot deal with such complex evaluations, a different approach was followed whereby the sound emission levels of buses operating under different conditions were actually measured in Mississauga and the results were then used to compose overall noise exposure levels at the specific points of reception.

Bus sound level measurements were taken within the City of Mississauga's Transit Garage located at 975 Central Parkway West. The measured bus sound emission levels were used in the subsequent calculations of the bus station sound levels.

Sound levels due to bus activities within the bus stations were calculated using an ISO based 3-D computer program developed by SS Wilson Associates for multiple receptors and multiple noise sources. The program takes into account the following factors:

- Reference sound levels and reference distances for the various bus movements or activities.
- Reference sound levels for vehicular traffic activities within the parking area.
- Volume of buses.
- Divergence (distance) attenuation.
- Sound barrier attenuation, where applicable.
- Ground and Atmospheric attenuation (as modified by source/receiver elevations and the intervening sound barrier).
- Source and receptor elevations.

The predicted day and night (i.e. Leq[16h] and Leq[8h]) future sound levels including the BRT busway sound levels are listed in Table 4.2, while the predicted hourly day, evening and night (i.e. Leq[1h]) BRT bus station sound levels are listed in Table 4.3.

Appendix A contains the bus traffic data used for bus noise calculations, while Appendix C includes sample bus noise calculations.

Since no detailed station plans are available at this time to show the design of the specific station where a station building will be constructed, the noise from

any potential mechanical equipment such as ventilation fans and air conditioning equipment was not considered at this point. It is worth noting that the noise from mechanical equipment are expected to be lower than the noise generated by the bus/car movements and also due to the present of high ambient/background sound levels.

4.4 SOUND LEVEL MEASUREMENTS

General

Short term (attended) bus and long term (unattended) ambient sound level readings were taken during the course of preparation of this noise study.

The scope of bus noise measurements was to conduct actual field testing of the sound levels emitted by the City of Mississauga buses when operated under normal operating conditions for the purpose of estimating the overall sound levels generated by the busway and stations. The bus sound levels measured may be considered as sound emission levels for buses performing different operations such as idling, accelerating, decelerating, etc.

The scope of the ambient noise measurements was to conduct actual field testing to confirm the accuracy of the predicted ambient noise level in order to support and enhance the calculated levels and indicate if and where anomalies exist in the prediction model.

Instrumentation

The attended bus sound level measurements were performed using the following equipment:

- Rion NA-28 & NA-27, Type 1 Precision Integrating Sound Level Meters and Real Time Frequency Analyzers fitted with 1/1 & 1/3 Octave Bands filters and 1/2” condenser microphones c/w windscreen and mounted on tripods.
- Bruel & Kjaer Precision Calibrator Model B&K 4231.

The unattended ambient sound level measurements were performed using the following equipment:

- Six Rion NL-22 Integrating Sound Level Meters fitted with 1/2” condenser microphones c/w windscreens. The sound level meters were contained in weather-protected environmental casings.
- Bruel & Kjaer Precision Calibrator Model B&K 4231.
- Ancillary field equipment including tripods and telescopic poles

Procedures

The sound level measurement procedures were primarily based on the Ministry of Environment procedures in their Publication NPC-103 “Procedures”, the recommendations of the instrument manufactures and the best engineering practices to suit site specific conditions. The sound level meters were checked and calibrated before and following completion of the measurement sessions without any appreciable change in the sound levels.

The weather conditions during the measurement sessions were favourable for measurements as the local wind speed did not exceed 25 km/hr and there was no precipitation.

The attended bus measurements were carried out on Friday, September 28 and Friday, October 3, 2007, while the unattended ambient measurements were carried out from Wednesday, June 11 to Sunday, June 15, 2008.

Locations

The following gives a brief description of the sound level measurements locations:

Attended Bus Measurements

The measurements were conducted within the City of Mississauga Transit Garage located at 975 Central Parkway West at set distance setbacks of 10m from bus moving lane and of 7.5m from bus idling bays.

The buses tested included typical vehicles of the Mississauga Transit fleet that will be used on the BRT corridor including articulated vehicles due to their potential for higher sound levels.

Unattended Ambient Measurements

Six locations were selected for noise measurements. The measurement locations are taken at points of reception Rw3, Rw5, Rw11, Rw20, Rw21 and Rw22.

Locations Rw3 and Rw5 represent residences located north of the future Winston Churchill bus station, location Rw11 represents residences located north of the future Erin Mills Parkway bus station, and locations Rw20, Rw21 and Rw22 represent residences located along Thorn Gardens and Remea Court.

Table 2 includes a summary of the logarithmically averaged bus and car sound levels, which were used for sound level modeling in this report.

Table 3.1 includes the daytime and nighttime measured ambient sound levels

(i.e. Leq [16h] and Leq [8h]), while Table 3.2 includes the lowest measured ambient noise levels during the day, evening and night (i.e. Leq [1h]).

Figures 2.1 to 2.7 show the unattended ambient noise measurement locations.

Appendix B includes the noise measurement results.

4.5 RESULTS

The overall existing sound levels were found to be largely due to vehicular traffic on the existing Highway 403, interchange ramps and arterial roads.

The measured existing day and night ambient sound levels are in the range of Leq (16h) 55 to 65 dBA day and 53 to 62 dBA night (ref. Table 3.1).

The measured lowest existing hourly ambient sound levels are Leq(1h) 64dBA day, 60 dBA evening and 64 dBA night (ref. Table 3.2).

Sound levels were predicted due to three different noise sources:

1. Bus traffic along the Busway.
2. Activities within the stations. These include local and BRT buses entering into, exiting from, maneuvering and idling within the station boundaries as well as cars entering into, exiting from and idling within the Kiss & Ride and Park & Ride Facilities (where applicable).
3. Vehicular traffic on the existing Highway 403, interchange ramps and arterial roads. These constitute the sources of ambient sound levels.

The predicted existing ambient sound levels are in the range of Leq (16h) 50 to 66 dBA day (ref. Tables 4.1 and 4.2).

The predicted future ambient sound levels are in the range of Leq (16h) 51 to 67 dBA day (ref. Table 4.1).

The predicted future overall project sound levels (including the BRT system) are in the range of Leq (16h) 51 to 68 dBA day (ref. Table 4.2).

The predicted lowest existing hourly ambient sound levels are Leq(1h) 63 dBA day, 63 dBA evening and 63 dBA night, while the predicted highest hourly future BRT station sound levels are Leq(1h) 62 dBA day, 59 dBA evening and 56 dBA night (ref. Table 4.3).

Table 5.1 includes comparisons between the measured and predicted average day and night ambient sound levels, while Table 5.2 includes comparisons between the measured and predicted lowest hourly day, evening and night ambient sound levels.

The comparisons show differences of up to 3 dBA between the measured and predicted sound levels. These differences are considered to be acoustically insignificant and are attributed to variations in the road traffic data used in the predictions and the one measured in the field and to the presence of external noise sources that could not be accounted for in the prediction model. Therefore, the use of the predicted levels in this study is considered as being more consistent for noise impact assessment purposes.

4.6 NOISE IMPACT ASSESSMENT

In impact assessment of highway projects, in general the MOE recommends comparing the predicted future sound levels of the undertaking with the existing ambient sound levels and/or the future-do-nothing without the undertaking sound levels. The degree of change between any two sound levels reflects the significance of the impact, whether an increase in the level (undesirable) or a decrease in the level (desirable). In addition, the magnitude of the change is also important in assessing how the public would react, in general, to the increased or decreased highway noise levels.

For this project, a new dimension has been added, which is the BRT noise component as it relates to the existing ambient due to Highway 403, interchange ramps and arterial roads. The latter noise is also subject to change from existing to future conditions with the natural increase in highway/roadway traffic without the BRT component. The existing Highway 403, interchange ramps and arterial roads traffic is a dynamic element, which is expected to also increase with or without the BRT system.

Accordingly, the impact assessment methodology followed in this study relied on the following:

(i) For receptors located along the BRT route, the impact is assessed for Outdoor Living Areas (OLA's) and is based on the following:

- Comparing the future sound level including the BRT noise component with the future sound level excluding the BRT noise component.
- For information purposes, we are providing a comparison of the future sound level including the BRT system component noise with the existing ambient sound level, which represents the actual magnitude of the change in sound level the general public will be exposed to due to the combined effect of the future road noise and the BRT system noise. While this comparison is factual, it does not represent the potential change due to the BRT system noise and accordingly, was not used for decision making purposes.

(ii) For receptors located in proximity to the BRT stations (not bus stops), the impact is assessed at the second storey windows on the most exposed building façades of the residential dwellings and is based on comparing the future (worst case scenario) BRT station noise levels with the higher of the existing highway/roadway ambient noise level or the minimum exclusionary sound level limits set by the MOE for Urban Class 1 Areas similar to the one under consideration.

The data included in Tables 4.1 and 4.2 show that the ambient and future sound levels at most of the selected receptors are higher than the MOE/Region/City day-time Leq 55 dBA objective. The data also show that the maximum calculated excess future sound level over the ambient is 3 dBA, i.e. acoustically noticeable and is within the maximum 5 dBA excess criterion.

The data included in Table 4.3 show that in the case of the station activities, there is no calculated excess sound level over the ambient, i.e. the station sound levels are predicted to be within the applicable criteria.

4.7 MITIGATION

For bus movements along the BRT busway, mitigation is warranted if the excess of the future sound levels above the ambient is greater than 5 decibels in the Outdoor Living Areas (OLA's).

For bus/car operations within the BRT stations, mitigation is warranted if the future sound levels exceed the higher of the existing ambient levels or the MOE exclusionary limits for Urban Class 1 Areas. (MOE Class 1 Area means an area with an acoustical environment typical of a major population centre, where the background noise is dominated by the urban hum).

The purpose of mitigation, when introduced is to reduce (as administratively, economically and technically feasible) the predicted future project noise levels to the objective level. The objective level is the higher of ambient noise level or Leq (16h) 55 dBA in the case of bus movements along the BRT busway and the higher of ambient noise level or Leq (1h) 50 dBA day/47dBA evening/45dBA night in the case of bus/car activities within the BRT stations.

The most widely accepted noise control measure is to construct sound barriers at appropriate locations to protect the receptors of concern. The preferred location of the barrier is within the right-of-way of the BRT alignment/station property to facilitate barrier maintenance by the City. A sound barrier may take the form of a berm, acoustic wall or a combination thereof. A minimum reduction of 5 dBA is considered as the least sound level reduction to justify the use of a sound barrier.

In accordance with the applicable sound level criteria, no noise mitigation is warranted since the noise impact due to the BRT Busway is predicted to be less

than 5 dBA and the noise impact due to the BRT stations is predicted to be within the prevalent ambient noise.

5.0 FINDINGS AND RECOMMENDATIONS

5.1 FINDINGS

This study has been carried out to research all aspects related to the potential noise impact of the BRT system on the nearby noise-sensitive areas which also include two bus stations. The study dealt with documentation of the existing ambient conditions, the applicable criteria, the future sound levels and noise control measures, where warranted. The study has found that:

1. Vehicular traffic on Highway 403, interchange ramps and arterial roads is considered as the major source of environmental ambient noise within the study area.
2. The predicted sound levels at most of the residences prior to undertaking of the BRT system do exceed the Provincial/Region/City objective of Leq 16 hours 55 dBA due to their close proximity and wide exposure to the existing network of highways and roads. For existing residences (i.e. all residences within the study area), outdoor noise control measures are not warranted if the Outdoor Living Areas sound levels exceed 55dBA.
3. The established excess sound levels due to the BRT system over the existing and future-do-nothing ambient sound levels are predicted to be no greater than 3dBA; i.e. within the maximum allowable excess of 5 dBA.
4. The BRT alignment has been selected in areas that are dominated by noise from well established arterial roads and Highway 403; i.e. the alignment is acoustically compatible with the existing land uses.

5.2 RECOMMENDATIONS

In accordance with MOE Condition of Approval #3, the following recommendations are made in keeping with the 1991 Noise Report:

1991 Noise Report Recommendations	Preliminary Design Recommendations
1. The noise impact due to ultimate bus traffic on the proposed Busway system is considered minor with respect to all locations along the proposed alignment since the increase in sound levels due to bus traffic on the proposed Busway would be a maximum of 5 dBA. This increase is within the MOE/MTO acceptable Protocol criteria for new and expanded roadway projects. Accordingly, additional noise control measures are NOT required.	Recommendation verified during this assessment. The increase is anticipated to be 3 dBA, which is well below the 5 dBA threshold and is mainly attributed to the forecasted increase in the future traffic volumes of the highways/roadways within the study area.

2. In the case of the receptors located in the vicinity of the proposed stations, the overall combined noise impact is also considered minor with respect to all proposed stations, and additional noise control measures are also NOT warranted.	Recommendation verified during this assessment
3. To meet the MOE requirements for stationary noise sources during the construction phase of the proposed undertaking, construction equipment used on the site should meet the sound emission level standards set by the MOE. The MOE assesses noise impact during the construction period against the sound level standards set out in Publications NPC-115 and NPC-118 (see Appendix D). These standards limit the allowable levels from the equipment at source rather than at the receiver. In order to meet the above requirements, the equipment will have to be certified by the manufacturer. If such certification is not available or if the equipment is not new, it will be required that the proponent certifies that the actual equipment used based on "on-site" measurements, under typical operating conditions comply with the MOE requirements. Other relevant standards include the Federal Government Standards regulating the noise emissions from heavy and medium trucks.	Recommendation verified during this assessment The following Federal and Provincial Government Standards will be met for this project: - Noise Emissions (Transport Canada Standard 1106) - NPC-115 (Construction Equipment) - NPC-118 (Motorized Conveyances) Appendix D includes copies of these Standards.
4. To improve the acoustical performance of the proposed Busway cuts we recommend that the wall construction materials have reasonable sound absorptive qualities and/or by constructing the cut sidewalls using an outward slope or slant. These measures will improve both the noise perceived at the near-by receptors, the transit system riders and the bystanders.	This recommendation is not made in this assessment since there are no nearby noise sensitive (residential or commercial) buildings exposed to the BRT cut sections where the acoustically absorptive wall treatment is required to offset the adverse effect of sound reverberations.

Monitoring

In accordance with an MOE Condition of Approval for the EA Addendum, the following outlines commitments to noise monitoring:

- Sound level monitoring of the existing ambient shall be carried out in advance of and during construction as well as during operations at the residences near the Erin Mills Parkway and Winston Churchill Boulevard BRT stations. Monitoring shall be carried out continuously (24 hours, on hourly basis) over a minimum period of 5 days to include 3 weekdays, Saturday and Sunday at typical points of reception that are expected to receive the highest impact.
- Monitoring shall be based on the Ministry of Environment Publications NPC-102 "Instrumentation" and NPC-103 "Procedures" (copies included in Appendix D).
- A noise monitoring report shall be prepared to contain all the relevant data and in accordance with the relevant technical requirements included in MOE Publications NPC-233 "Guidelines on Information Required for the Assessment of Planned Stationary Sources of Sound) and NPC-134 "Guidelines on Information for the Assessment of Planned New Land Uses with respect to Sound and Vibration Impacts" (copy of latter included in Appendix D).
- Noise monitoring reports will be submitted to Transport Canada at appropriate intervals during construction.
- It is possible that the monitoring may identify noise effects that will warrant a review of the application of new noise mitigation measures. Should mitigation be warranted a review of appropriate noise control measures will be completed with consideration given to the technical, administrative and economic feasibility of the various mitigation alternatives.
- The monitoring plan will be refined and finalized in advance of construction and in consultation with MOE.

Construction Noise

Worst-case construction noise levels have the potential to be very loud during some short periods of time. However, noise effects from construction are relatively short compared to operational noise effects, and therefore, they are usually better tolerated by the community at large. As previously noted, the closest sensitive receptors are residences along Colombo Crescent and Radisson Crescent which are to the north of the Winston Churchill Station and the Erin Mills Station respectively. The property lines of those properties are approximately 15m from the north side of the stations. There are no other sensitive receptors (e.g. hospitals, daycares, seniors residences) in such close proximity to the alignment. Most receptors are within no less than 50 m from the busway.

The following provides an overview of typical construction equipment sound levels.

EQUIPMENT DESCRIPTION	SOUND LEVEL dBA at 15m Reference Distance
Idling Truck	73
Trucks Unloading	78
Truck Moving	83
Bulldozer	85
Front End Loader	85
Chain Saw	78
Scraper	88
Roller	80
Backhoe	85
Crane	83
Diesel Generator	78
Grader	85
Compactor	74
Curb Machine	89
Concrete Truck (Unloading)	73
Cable Trencher	85
Asphalt Machine	74
Jack Hammer	85
Compressor	85

With the application of the following noise mitigation, it is not anticipated that there will be significant adverse noise effects during construction:

- Restricting noisy activities to daytime hours where possible;
- Adhering to the City of Mississauga's Noise Control By-law; and
- Implementing the noise control procedures during construction.

To minimize the potential for construction noise effects, the following provisions will be written into the contract documentation for the contractor.

- General construction will be limited to the time periods outlined in the City of Mississauga's Noise Control By-law. If construction activities are required outside of these hours, exemptions will be sought in advance by the contractor, directly from the City of Mississauga.
- There will be explicit indication that contractors are expected to comply with all applicable requirements of the contract and local noise by-laws. Enforcement of noise control by-laws will be the responsibility of the City of Mississauga for all work done by contractors.
- All equipment will be properly maintained to limit noise emissions in compliance with MOE NPC-115 guidelines. As such, all construction equipment will be operated with effective muffling devices that are in good

working order.

- The contract documents will contain a provision that any initial noise complaint will trigger verification that the general noise control measures agreed to are in effect.
- In the presence of persistent noise complaints, all construction equipment will be verified to comply with MOE NPC-115 guidelines.
- In the presence of persistent complaints and subject to the results of a field investigation, alternative noise control measures may be required, where reasonably available. In selecting appropriate noise control and mitigation measures, consideration will be given to the technical, administrative and economic feasibility of the various alternatives.
- Construction mitigation alternatives include but are not limited to:
  - Re-scheduling of noisy operations to daytime hours, where possible;
  - Use of alternate, quieter equipment or methods, where available; and
  - The use of portable, localized noise barriers for critical areas.
- The monitoring program (discussed above) will be implemented to monitor for potential effects due to construction noise. The noise monitoring program requirements will be identified during Detail Design and MOE will be consulted as necessary in the development of the program.
- Noise monitoring reports will be submitted to Transport Canada at appropriate intervals during construction.

Maintenance Noise

Worst-case maintenance noise levels have the potential to be very loud during some short periods of time. However, noise effects from maintenance activities are relatively short compared to operational noise effects, and therefore, they are usually better tolerated by the community at large.

With the application of the following noise mitigation, it is not anticipated that there will be significant potential noise effects during future maintenance activities:

- Restricting noisy activities to daytime hours where possible; and
- Adhering to the City of Mississauga's Noise Control By-law and seeking and obtaining exemptions as warranted.

TABLES

TABLE 1
SUMMARY OF NOISE IMPACT RATING AND ACTION FOR MITIGATION

Future Sound Level, $Leq_{16\ hr}$	Change Above Future Do-Nothing Ambient, dBA	Impact Rating	Mitigation
Equal to or greater than 55 dBA and less than 65 dBA	0 - 3	Insignificant	None
	3 - 5	Noticeable	None
	>5 - 10	Significant	Investigate noise control measures and mitigate to achieve criteria (minimum attenuation is 5 dBA)
	10 +	Very Significant	Investigate noise control measures and mitigate to achieve criteria (minimum attenuation is 5 dBA)
Greater than 65 dBA	0 – 3	Insignificant	Investigate noise control measures and mitigate to achieve criteria (minimum attenuation is 5 dBA)
	3 – 5	Noticeable	Investigate noise control measures and mitigate to achieve criteria (minimum attenuation is 5 dBA)
	>5 – 10	Significant	Investigate noise control measures and mitigate to achieve criteria (minimum attenuation is 5 dBA)
	10 +	Very Significant	Investigate noise control measures and mitigate to achieve criteria (minimum attenuation is 5 dBA)

Note: Mitigation efforts are subject to administrative, economical and technical feasibility.

TABLE 2
SUMMARY OF BUS AND CAR SOUND EMISSION LEVELS

Activity	Sound Emission Level
Bus Moving (slow speed)	73 dBA @ 10m
Bus Idling (normal idle)	71 dBA @ 7.5m
Car Moving (slow speed)	60 dBA @ 15m
Car Idling (normal idle)	56 dBA @ 7.0m

TABLE 3.1
MEASURED DAY AND NIGHT AMBIENT SOUND LEVELS

Location	Day Leq (16h)	Night Leq (8h)
Rw3	57 to 65 dBA	59 to 61dBA
Rw5	56 to 64 dBA	58 to 60 dBA
Rw11	58 to 65 dBA	60 to 62 dBA
Rw20	57 to 59 dBA	57 to 59 dBA
Rw21	58 to 60 dBA	55 to 57 dBA
Rw22	55 to 58 dBA	53 to 56 dBA

TABLE 3.2
MEASURED LOWEST HOURLY AMBIENT SOUND LEVELS

Location	Day Leq (1h)	Evening Leq (1h)	Night Leq (1h)
Rw5	64 dBA	60 dBA	64 dBA
Rw11	64 dBA	63 dBA	65 dBA

Notes

(1) MOE time periods:

- Day: 7am -7pm
- Evening 7pm-11pm
- Night:11pm-7am

(2) Time periods used in this study to coincide with BRT station peak hours:

- Day: 7am-10am
- Evening: 7pm-8pm
- Night: 6am-7am

TABLE 4.1
ENVIRONMENTAL NOISE IMPACT ASSESSMENT
WITHOUT BRT WEST
CITY OF MISSISSAUGA

Receptor Code	Existing Sound Levels dBA	Future Sound Levels dBA	Government Leq Sound Level Objective dBA	Excess Criteria for Mitigation dBA	Future Sound Levels Minus Existing Sound Levels	Significance of the Change due to the Future Sound Levels Minus Existing Sound Levels	Noise Control Measures
Rw1	58.9	59.9	55	5	1	Insignificant	Not required
Rw2	59.5	60.8	55	5	1	Insignificant	Not required
Rw3	59.3	60.8	55	5	2	Insignificant	Not required
Rw4	58.9	60.3	55	5	1	Insignificant	Not required
Rw5	53.9	55.7	55	5	2	Insignificant	Not required
Rw6	59.0	60.3	55	5	1	Insignificant	Not required
Rw7	58.4	59.6	55	5	1	Insignificant	Not required
Rw8	59.6	61.1	55	5	1	Insignificant	Not required
Rw9	60.0	61.0	55	5	1	Insignificant	Not required
Rw10	60.5	62.0	55	5	2	Insignificant	Not required
Rw11	60.3	62.7	55	5	2	Insignificant	Not required
Rw12	59.4	60.6	55	5	1	Insignificant	Not required
Rw13	65.9	67.3	55	5	1	Insignificant	Not required
Rw14	58.5	59.9	55	5	1	Insignificant	Not required
Rw15	58.4	59.5	55	5	1	Insignificant	Not required
Rw16	60.0	61.7	55	5	2	Insignificant	Not required
Rw17	58.8	59.5	55	5	1	Insignificant	Not required
Rw18	57.8	58.9	55	5	1	Insignificant	Not required
Rw19	50.0	51.1	55	5	1	Insignificant	Not required
Rw20	56.2	57.6	55	5	1	Insignificant	Not required
Rw21	59.4	60.7	55	5	1	Insignificant	Not required
Rw22	60.7	62.0	55	5	1	Insignificant	Not required

Impact Assessment Rating : 0 to < 3 dB change : Insignificant; =>3 to < 5 dB change : Noticeable; => 5 to < 10 dB change: Significant; => 10 dB change : Very Significant

TABLE 4.2
ENVIRONMENTAL NOISE IMPACT ASSESSMENT
WITH BRT WEST
CITY OF MISSISSAUGA

Receptor Code	Existing Sound Levels dBA	Future Sound Levels dBA	Government Leq Sound Level Objective dBA	Excess Criteria for Mitigation dBA	Future Sound Levels Minus Existing Sound Levels	Significance of the Change due to the Future Sound Levels Minus Existing Sound Levels	Noise Control Measures
Rw1	58.9	59.9	55	5	1	Insignificant	Not required
Rw2	59.5	60.8	55	5	1	Insignificant	Not required
Rw3	59.3	60.9	55	5	2	Insignificant	Not required
Rw4	58.9	60.5	55	5	2	Insignificant	Not required
Rw5	53.9	56.1	55	5	2	Insignificant	Not required
Rw6	59.0	60.6	55	5	2	Insignificant	Not required
Rw7	58.4	59.7	55	5	1	Insignificant	Not required
Rw8	59.6	61.2	55	5	2	Insignificant	Not required
Rw9	60.0	61.3	55	5	1	Insignificant	Not required
Rw10	60.5	62.2	55	5	2	Insignificant	Not required
Rw11	60.3	63.5	55	5	3	Noticeable	Not required
Rw12	59.4	61.6	55	5	2	Insignificant	Not required
Rw13	65.9	67.5	55	5	2	Insignificant	Not required
Rw14	58.5	61.1	55	5	3	Insignificant	Not required
Rw15	58.4	59.5	55	5	1	Insignificant	Not required
Rw16	60.0	61.7	55	5	2	Insignificant	Not required
Rw17	58.8	59.5	55	5	1	Insignificant	Not required
Rw18	57.8	58.9	55	5	1	Insignificant	Not required
Rw19	50.0	51.1	55	5	1	Insignificant	Not required
Rw20	56.2	57.6	55	5	1	Insignificant	Not required
Rw21	59.4	60.7	55	5	1	Insignificant	Not required
Rw22	60.7	62.0	55	5	1	Insignificant	Not required

Impact Assessment Rating :

0 to < 3 dB change : Insignificant
=>3 to < 5 dB change : Noticeable
=> 5 to < 10 dB change: Significant
=> 10 dB change : Very Significant

TABLE 4.3
ENVIRONMENTAL NOISE ASSESSMENT
PROPOSED MISSISSAUGA BRT STATIONS

Receptor	Time	Maximum Bus Station Sound Level Leq (1h)	Minimum Ambient Noise Level Leq (1h)	MOE Exclusion Limit Leq (1h)	Applicable Criteria Leq (1h)	Excess of Bus Station Sound Level Above Applicable Criteria
Winston Churchill Boulevard Bus Station						
Rw4	Day	54 dBA	64 dBA	50 dBA	64 dBA	n/a
	Evening	52 dBA	63 dBA	47 dBA	63 dBA	n/a
	Night	49 dBA	64 dBA	45 dBA	64 dBA	n/a
Rw5	Day	58 dBA	63 dBA	50 dBA	63 dBA	n/a
	Evening	56 dBA	63 dBA	47 dBA	63 dBA	n/a
	Night	54 dBA	63 dBA	45 dBA	63 dBA	n/a
Rw6	Day	62 dBA	64 dBA	50 dBA	64 dBA	n/a
	Evening	59 dBA	65 dBA	47 dBA	65 dBA	n/a
	Night	56 dBA	64 dBA	45 dBA	64 dBA	n/a
Erin Mills Parkway Station						
Rw11	Day	58 dBA	65 dBA	50 dBA	57 dBA	n/a
	Evening	56 dBA	63 dBA	47 dBA	55dBA	n/a
	Night	53 dBA	65 dBA	45 dBA	51 dBA	n/a

TABLE 4.3 Cont'd
ENVIRONMENTAL NOISE ASSESSMENT
PROPOSED MISSISSAUGA BRT STATIONS

Receptor	Time	Maximum Bus Station Sound Level Leq (1h)	Minimum Ambient Noise Level Leq (1h)	MOE Exclusion Limit Leq (1h)	Applicable Criteria Leq (1h)	Excess of Bus Station Sound Level Above Applicable Criteria
Rw12	Day	62 dBA	64 dBA	50 dBA	64 dBA	n/a
	Evening	59 dBA	63 dBA	47 dBA	63 dBA	n/a
	Night	55 dBA	65 dBA	45 dBA	65 dBA	n/a
Rw13	Day	61 dBA	66 dBA	50 dBA	66 dBA	n/a
	Evening	58 dBA	65 dBA	47 dBA	65 dBA	n/a
	Night	54 dBA	66 dBA	45 dBA	66 dBA	n/a

TABLE 5.1
COMPARISON OF MEASURED VERSUS PREDICTED DAY AND NIGHT AMBIENT SOUND LEVELS

Location	Time	Measured Ambient Level	Predicted Ambient Level	Difference (Measured - Predicted Ambient)
Rw3	Day Leq(16h)	57 to 65 dBA	63 dBA	-6 to +2 dBA
	Night Leq(8h)	59 to 61 dBA	60 dBA	-1 to +1 dBA
Rw5	Day Leq(16h)	56 to 64 dBA	62 dBA	-4 to +2 dBA
	Night Leq(8h)	58 to 60 dBA	58 dBA	0 to +2 dBA
Rw11	Day Leq(16h)	58 to 65 dBA	64 dBA	-6 to +1 dBA
	Night Leq(8h)	60 to 62 dBA	59 dBA	+1 to +3 dBA
Rw20	Day Leq(16h)	57 to 59 dBA	56 dBA	+1 to +3 dBA
	Night Leq(8h)	57 to 59 dBA	51 dBA	+6 to +8 dBA
Rw21	Day Leq(16h)	58 to 60 dBA	59 dBA	-1 to +1 dBA
	Night Leq(8h)	55 to 57 dBA	54 dBA	+1 to +3 dBA
Rw22	Day Leq(16h)	55 to 58 dBA	61 dBA	-6 to -3 dBA
	Night Leq(8h)	53 to 56 dBA	56 dBA	-3 to 0 dBA

TABLE 5.2
COMPARISION OF MEASURED VERSUS PREDICTED HOURLY AMBIENT SOUND LEVELS

Location	Time	Measured Ambient Level, Leq(1h)	Predicted Ambient Level, Leq(1h)	Difference (Measured - Predicted Ambient)
Rw5	Day	64 dBA	63 dBA	+1 dBA
	Evening	60 dBA	63 dBA	-3 dBA
	Night	64 dBA	63 dBA	+1 dBA
Rw11	Day	64 dBA	65 dBA	-1 dBA
	Evening	63 dBA	63 dBA	0 dBA
	Night	65 dBA	65 dBA	0 dBA

Notes

(1) MOE time periods:

- Day: 7am -7pm
- Evening 7pm-11pm
- Night:11pm-7am

(2) Time periods used in this study to coincide with BRT station peak hours:

- Day: 7am-10am
- Evening: 7pm-8pm
- Night: 6am-7am

FIGURES

FIGURE 1
KEY PLAN

FIGURE 2.1
POINTS OF RECEPTION AND MEASUREMENT LOCATIONS

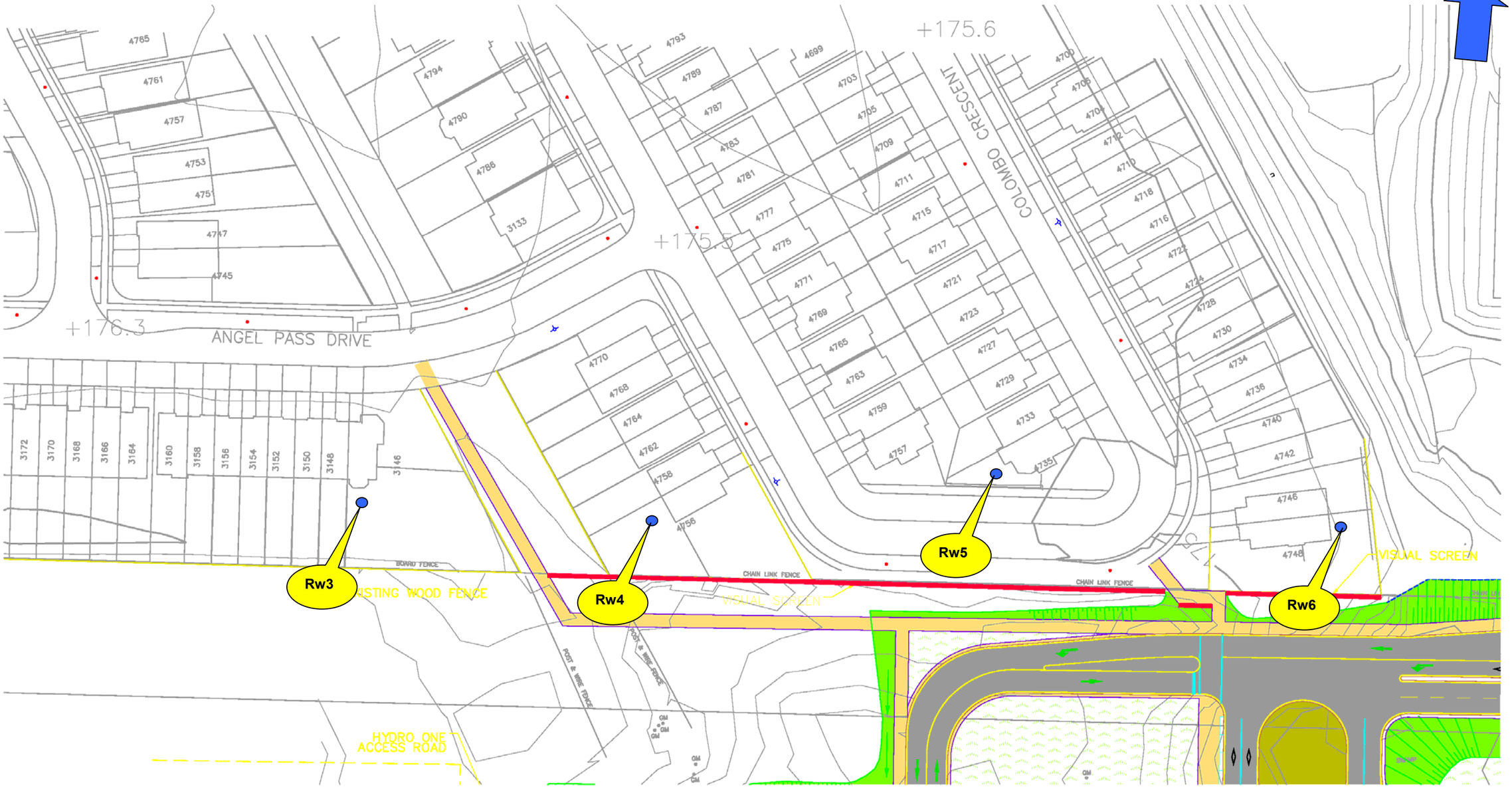


FIGURE 2.2
POINTS OF RECEPTION AND MEASUREMENT LOCATIONS

FIGURE 2.3
POINTS OF RECEPTION AND MEASUREMENT LOCATIONS

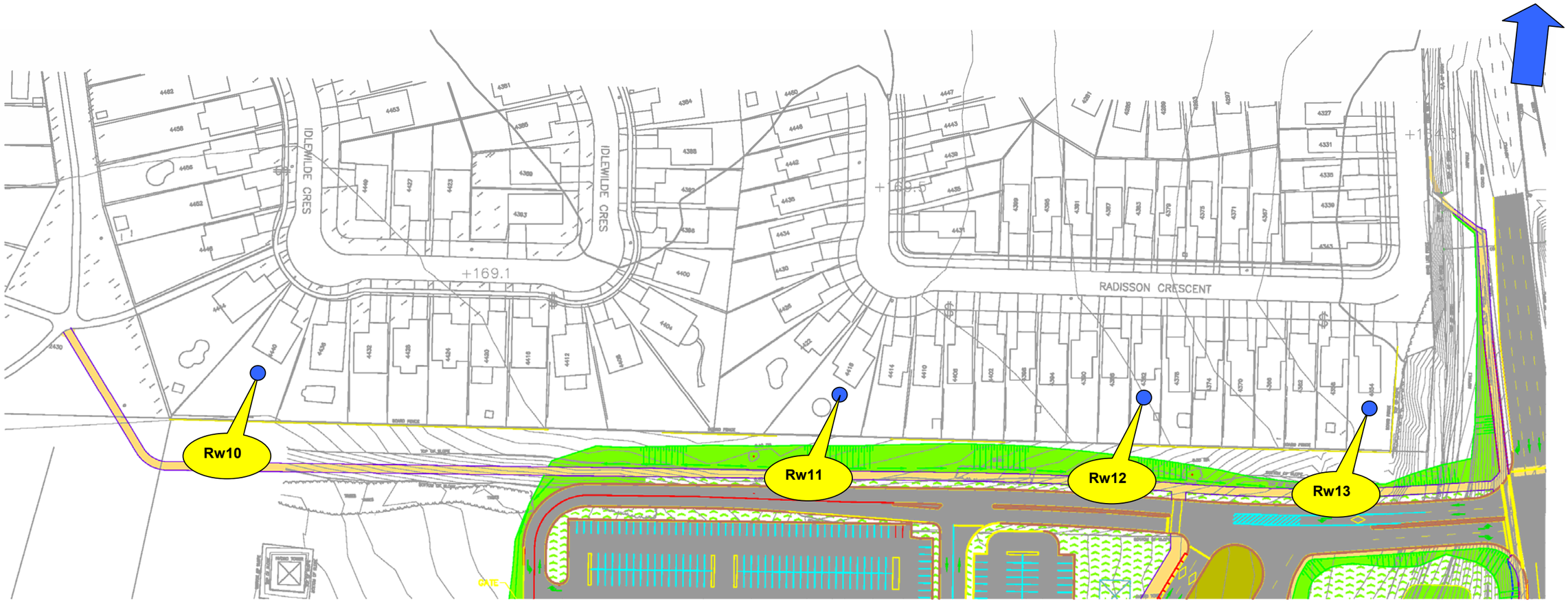


FIGURE 2.4
POINTS OF RECEPTION AND MEASUREMENT LOCATIONS

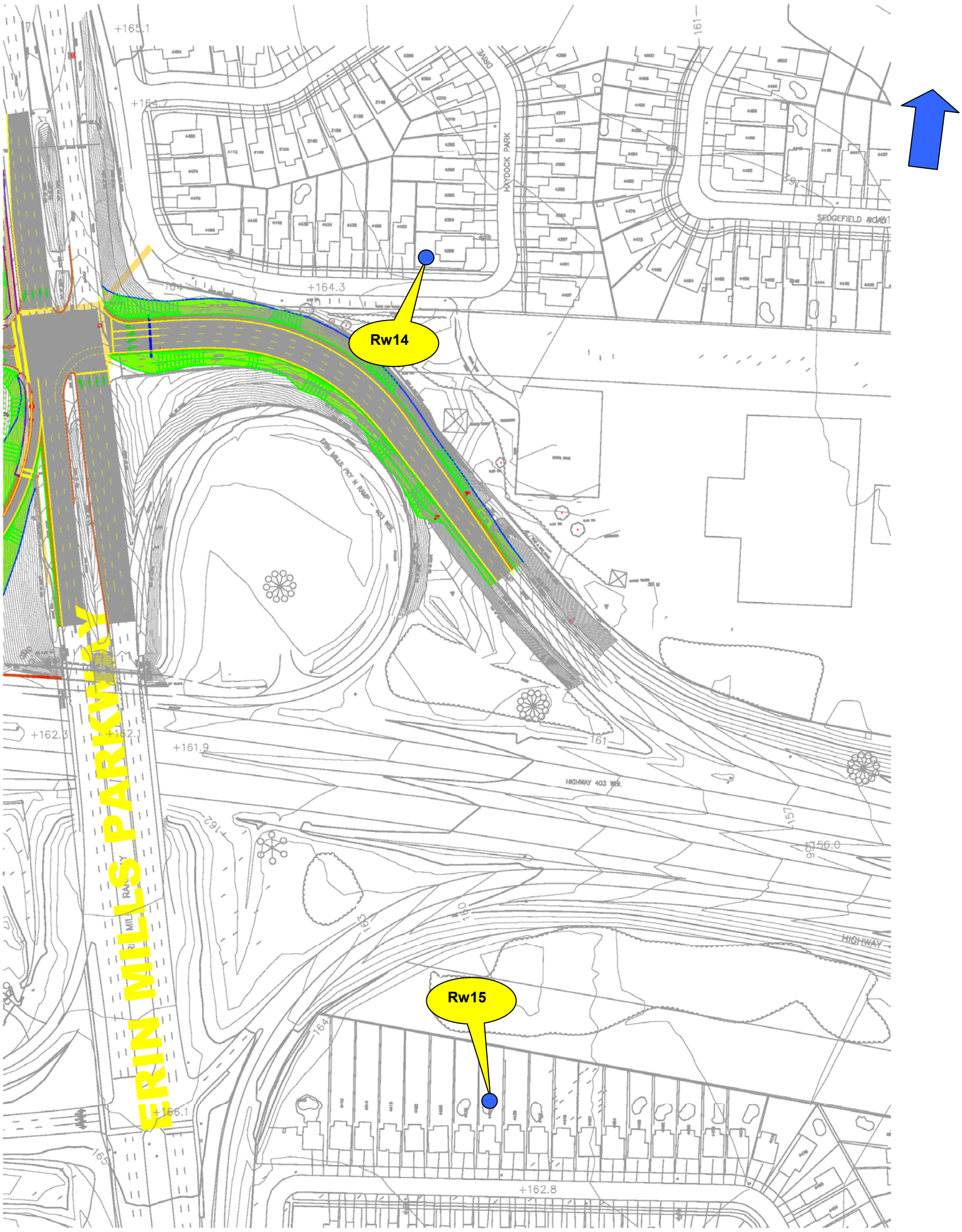


FIGURE 2.5
POINTS OF RECEPTION AND MEASUREMENT LOCATIONS

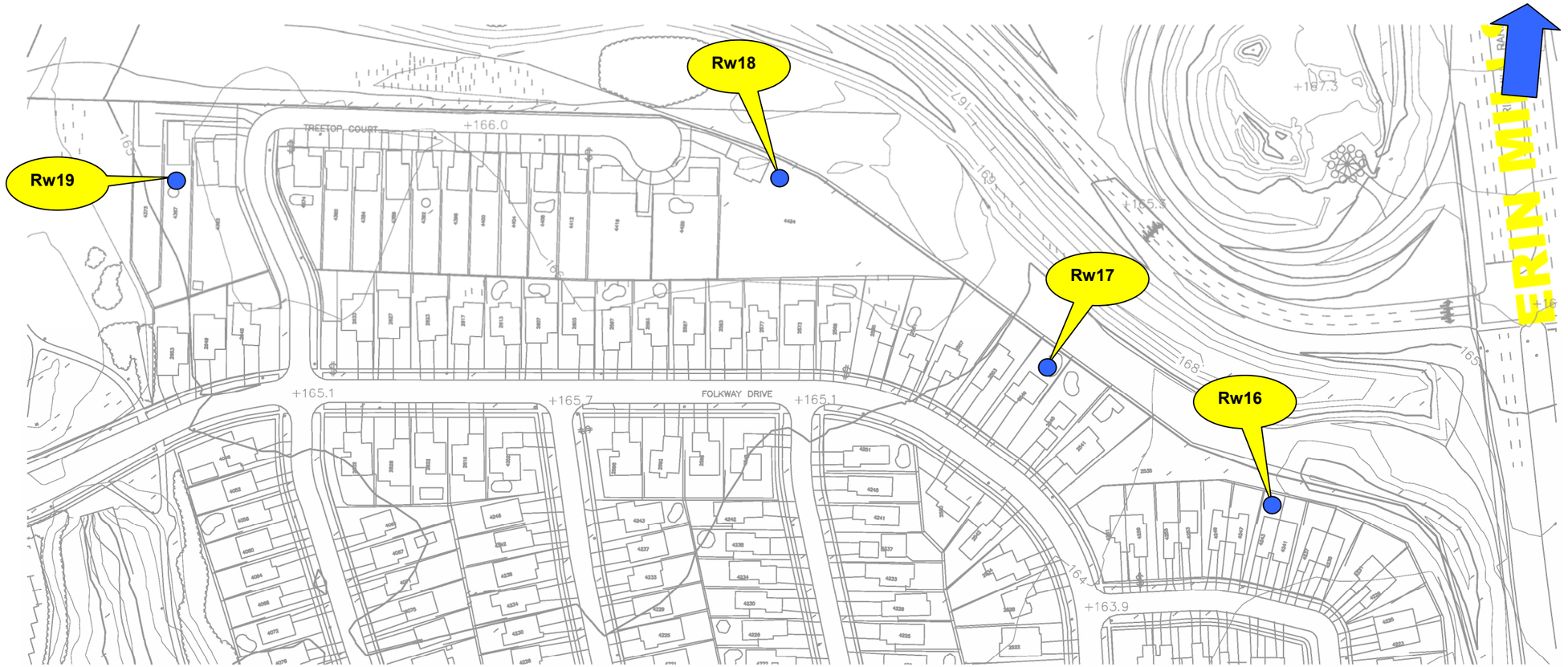
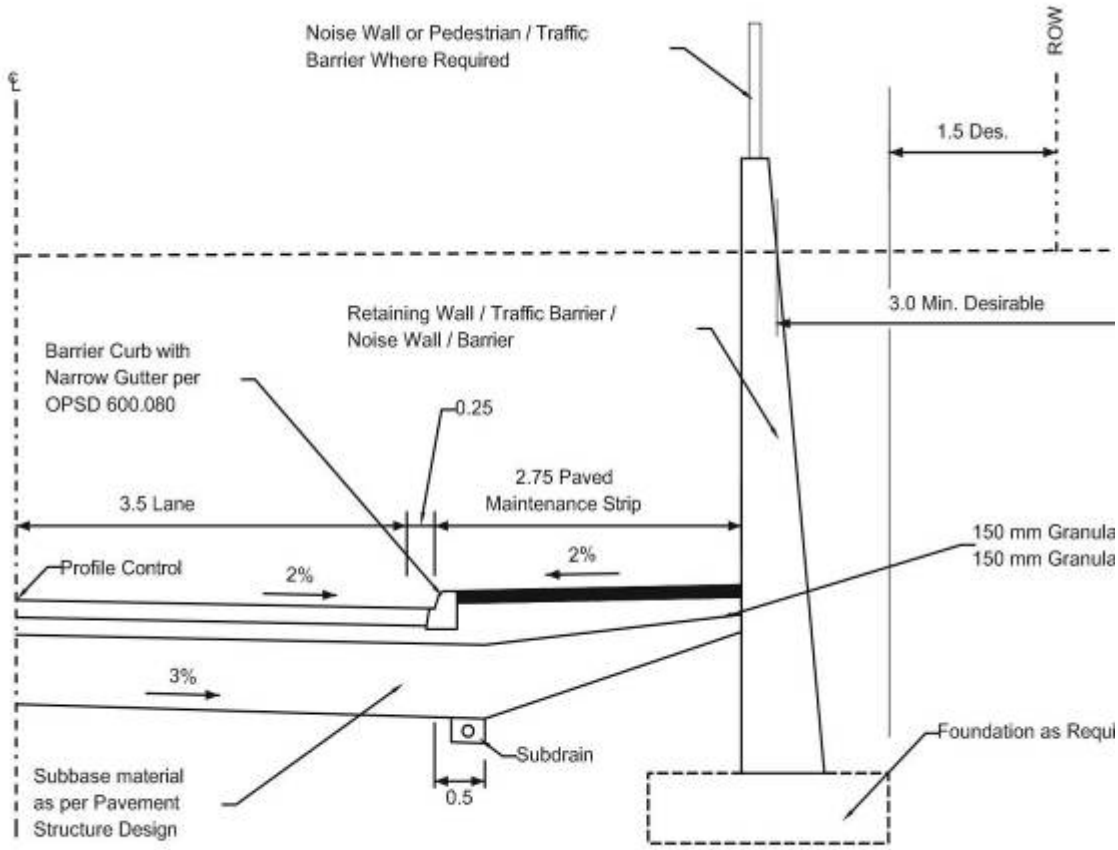


FIGURE 2.6
POINTS OF RECEPTION AND MEASUREMENT LOCATIONS

FIGURE 2.7
POINTS OF RECEPTION AND MEASUREMENT LOCATIONS



Cut Section Where Right-of-Way is Restricted

FIGURE 3
BRT BUSWAY RETAINED CUT

PHOTOGRAPHS

Photo 1: Residences & Noise Wall (north of Highway 403 & west of Winston Churchill Boulevard)

Photo 2: Residences & Noise Wall (north of Highway 403 & west of Winston Churchill Boulevard)

Photo 3: Earthen Berm (north of Highway 403 & west of Winston Churchill Boulevard)

Photo 4: Residences & Noise Wall (north of Highway 403 & west of Winston Churchill Boulevard)

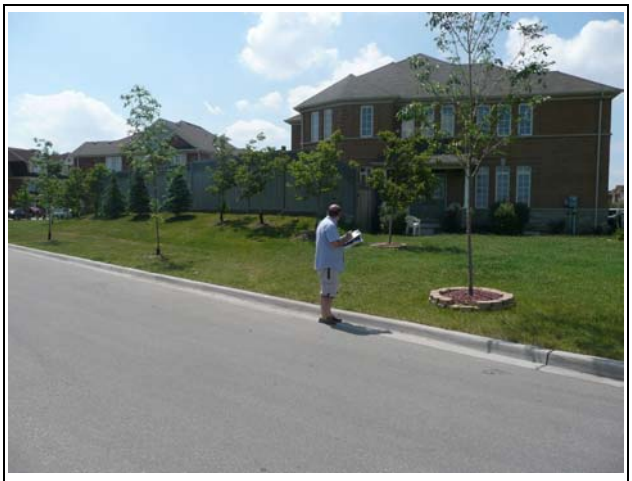


Photo 5: Residences & Noise Wall (north of Highway 403 & west of Winston Churchill Boulevard)

Photo 6: Residences & Noise Wall (north of Highway 403 & west of Winston Churchill Boulevard)

Photo 7: Earthen Berm + Noise Wall (south of Highway 403 between Winston Churchill Boulevard & Glen Erin Drive)

Photo 8: Earthen Berm + Noise Wall (south of Highway 403 between Winston Churchill Boulevard & Glen Erin Drive)

Photo 9: Earthen Berm (south of Highway 403 between Winston Churchill Boulevard & Glen Erin Drive)

Photo 10: Earthen Berm (south of Highway 403 between Winston Churchill Boulevard & Glen Erin Drive)

Photo 11: Earthen Berm (south of Highway 403 between Winston Churchill Boulevard & Glen Erin Drive)

Photo 12: Earthen Berm (south of Highway 403 between Winston Churchill Boulevard & Glen Erin Drive)

Photo 13: Earthen Berm (north of Highway 403 between Winston Churchill Boulevard & Glen Erin Drive)

Photo 14: Earthen Berm (south of Highway 403 between Glen Erin Drive and Erin Mills Parkway)

Photo 15: Earthen Berm (north of Highway 403 between Glen Erin Drive and Erin Mills Parkway)

Photo 16: Earthen Berm (south of Highway 403 between Glen Erin Drive and Erin Mills Parkway)

Photo 17: Earthen Berm + Noise Wall (south of Highway 403 between Winston Churchill Boulevard & Glen Erin

Photo 18: Earthen Berm (south of Highway 403 between Winston Churchill Boulevard & Glen Erin Drive)

APPENDIX A

TRAFFIC VOLUMES

The technical appendices for the noise analyses
are available on request from the Mississauga BRT Project Office

SS WILSON ASSOCIATES
Consulting Engineers

REPORT NO. WA07-090
REVISION 1

ENVIRONMENTAL NOISE STUDY
MISSISSAUGA BUS RAPID TRANSIT (BRT) SYSTEM
BRT EAST – HURONTARIO STREET TO RENFORTH DRIVE
CITY OF MISSISSAUGA

SUBMITTED TO:

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PROJECT ANALYST

APPROVED BY:

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PRINCIPAL

MAY 28, 2009

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ENVIRONMENTAL NOISE STUDY
MISSISSAUGA BUS RAPID TRANSIT (BRT) SYSTEM
BRT EAST – HURONTARIO STREET TO RENFORTH DRIVE
CITY OF MISSISSAUGA

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EXECUTIVE SUMMARY

This study has been carried out to investigate the potential noise impact of the proposed Mississauga Bus Rapid Transitway (BRT) East from Hurontario Street to Renforth Drive on the adjacent/nearby noise sensitive areas. The study dealt with the existing and future ambient as well as the future with the undertaking sound levels and their impact on the noise sensitive receptors.

The applicable sound level criteria are based on the Ministry of the Environment (MOE), Ministry of Transportation (MTO), Region of Peel and City of Mississauga noise guidelines and policies for transportation and stationary sources of noise.

Twenty six receptor locations were selected to represent the receptors (21 residential properties and 5 commercial properties) within the study area. Calculations for the busway were based on a Leq 16 hour daytime descriptor (i.e. 07:00-23:00) and a Leq 8 hour nighttime descriptor (i.e. 23:00-07:00). Calculations for the stations were based on a Leq 1 hour descriptor for day (i.e. 07:00 – 10:00), evening (i.e. 19:00 – 20:00) and night (i.e. 06:00-07:00) The day, evening and night hours used for noise assessment were selected to represent the peak (i.e. worst-case) operational hours for the stations.

The daytime ambient sound levels (levels without the busway) are predicted to be in the range of 50 to 65dBA (residential receptors) and 64 to 72dBA (commercial receptors) for the existing conditions and in the range of 51 to 67 dBA (residential receptors) and 65 to 73 dBA (commercial receptors) for the future conditions.

The daytime future sound levels associated with the Busway are predicted to be in the range of 44 to 55dBA (residential receptors) and 55 to 70dBA (commercial receptors), while the future sound levels associated with the BRT stations are predicted to be in the range of <40 to 53dBA day, <40 to 51dBA evening and <40 to 46dBA night (residential receptors).

Attended and unattended sound level measurements were taken at typical receptors (residences) in the study area. The measured daytime ambient sound levels are in the range of 49 to 62 dBA, while the measured nighttime sound levels are in the range of 51 to 60 dBA. The measured hourly ambient sound levels are in the range of 45 to 61 dBA day, 48 to 60 dBA evening and 54 to 63 dBA night.

The excesses of the measured daytime ambient sound levels over the corresponding predicted sound levels are in the range of 1 to 4dBA, which are considered to be acoustically insignificant to noticeable and are attributed to variations between the measured and modeled road traffic volumes and compositions and to the presence of exterior sources of noise that were not part of the prediction model. Based on this, the use of the predicted sound levels was

deemed to yield consistent and reasonable results for the purpose of this study.

Based on the MOE sound level criteria, all the residential receptors are predicted to have insignificant to noticeable noise impacts (in the range of 1 to <5dBA) and accordingly, there is no need to consider the application of noise control measures as the predicted increases do not exceed 5 dBA. On the other hand, some of the commercial receptors are predicted to have insignificant to significant noise impacts (in the range of 1 to <10dBA) and accordingly, there is a need to consider the application of noise control measures as the predicted increases exceed 5 dBA

Accordingly, the results of this investigation and the recommendations in this study recommend that noise control measures be installed at three different locations (near commercial properties at Tahoe Boulevard/Eastgate Parkway; Tahoe Boulevard/Eglinton Avenue West and Orbitor Drive/Eglinton Avenue West) within the study area as a result of bus operations within the BRT system.

In accordance with an MOE Condition of Approval for the EA Addendum, commitments are made with regards to noise monitoring timing, locations, duration, MOE governing guidelines, report contents and submittal, as well as noise mitigation, if warranted.

With respect to construction noise, the closest residences are identified to be along Audubon Boulevard, Copseholm Terrace, Curia Crescent, Rathburn Road East/Meadows Boulevard between Curia Crescent and Central Parkway East, Alta Court and Chalfield Lane and the closest commercial buildings are identified to be along Orbitor Drive/Eglinton Avenue West, Tahoe Boulevard/Eglinton Avenue West and Tahoe Boulevard/Eastgate Parkway. Typical construction equipment sound levels are provided along with several recommended noise mitigation measures to mitigate the adverse noise effects during construction. The latter include restricting noisy activities to daytime hours, adherence to City's Noise By-Law, implementation of control procedures during construction and the inclusion of special provisions in the contract documents.

Mitigation measures are also recommended to control noise levels due to maintenance activities, which include restricting noisy activities to daytime hours, adhering to the City's Noise Control By-law and seeking and obtaining exemptions as warranted.

1.0 INTRODUCTION

The services of SS Wilson Associates were retained by the Consulting Engineering firm, McCormick Rankin Corp. to prepare an Environmental Noise Study for the Mississauga Bus Rapid Transit (Mississauga BRT).

Mississauga's Rapid Transit program is centered on the Mississauga Bus Rapid Transit (Mississauga BRT) facility, a busway running across the heart of the City. The project is now getting underway, courtesy of funding from the federal, provincial, and municipal governments. The Preliminary Design of the facility is currently being undertaken and construction is scheduled to be completed by 2013.

The Mississauga BRT facility was planned and approved under the *Ontario Environmental Assessment Act* in the early 1990s, and an Environmental Assessment (EA) Addendum for an updated plan was approved in 2005. The EA and EA Addendum were reviewed and approved by the Ministry of the Environment (MOE) subject to some Conditions of Approval. Two of the Conditions of Approval required that additional noise assessment works be completed. The applicable Conditions of Approval are outlined below.

Given the requirements of the MOE Condition of Approvals, an updated noise assessment has been undertaken to identify potential effects, mitigation measures, and to develop a preliminary monitoring strategy to be refined during Detail Design and implemented during the construction and operations components of the project.

This report documents the updated noise assessment for the section of the BRT facility between Hurontario Street and Renforth Drive running alongside Eastgate Parkway and Eglinton Avenue West. That section of the BRT is also known as "BRT East". This noise assessment has been completed for the recommended Preliminary Design. An updated noise assessment is also being completed for the section of the BRT facility between Winston Churchill Boulevard and Erin Mills Parkway to the north of Highway 403 (BRT West). The BRT West noise analysis will be documented in a separate report.

The general location of the BRT East study area is shown in Figure 1.

The objectives of this study are to:

- Measure and predict the exiting ambient sound levels;
- Determine the potential changes to the existing ambient sound levels due to the undertaking;
- Assess the predicted changes in the noise environment and to recommend measures to mitigate and monitor noise effects as warranted and in accordance with the recommendations outlined in the 1991 noise report (ref. SS Wilson Associates Noise Report No. W90-72 dated February 1, 1991) and commitments

to future work as identified in the Environmental Assessment and Environmental Assessment Addendum.

A letter will be submitted to the Ministry of the Environment for their review and comment in support of compliance with the above-noted Conditions of Approval.

The Mississauga BRT is also subject to a Screening under the *Canadian Environmental Assessment Act*. In keeping with commitments made in the project-specific CEAA Screening Report, this report will also be submitted to Transport Canada for their review.

Condition of Approval of the EA Report (part of Condition #3)

As a Condition of Approval (part of Condition #3) to the EA Report, the MOE required that written confirmation be provided to indicate that the recommendations of the noise report prepared by S.S. Wilson in 1991 will be adhered to.

3. *Prior to commencement of construction and the completion of detailed construction design of a stage, the Corporation of the City of Mississauga shall supply to the Ministry of Environment and Energy's Director of Central Region for review and approval:*

   …

   - *A letter stating that all the recommendations contained in the S.S. Wilson and Associates Report, Environmental Noise Study, Proposed Mississauga Busway System, W90-72 (February 1, 1991) will be followed.*

Details regarding compliance with the recommendations from the previous noise report are outlined in Section 5.2 (Recommendations).

Condition of Approval of the EA Addendum Report

In response to the EA Addendum Report, the MOE recommended that following the design of the BRT the City should monitor noise levels near potentially affected residential sites to ensure that noise levels are in keeping with Ministry of the Environment noise guidelines.

> *In the approved EA, the City committed to monitoring noise levels prior to and following Transitway operation near potentially effected residential sites. During the preparation of the Addendum, public concern was expressed regarding noise levels in the Erin Mills Parkway area. Although the City has demonstrated that any increase in noise falls within Ministry guidelines, it is recommended that the City continue to monitor noise levels after the design stage in the Erin Mills Parkway area to ensure that these levels are in keeping with the Ministry of the Environment noise guidelines.*

This study represents a joint effort with the Consulting Engineering Firm, McCormick Rankin Corp., who provided the necessary traffic data and overall project direction.

This Revision 1 incorporate the comments received from the Ministry of the Environment in regards to the clarification of several statements, the correction factor of +5 dBA and typographical errors.

2.0 GENERAL APPROACH AND PROJECT DESCRIPTION

2.1 General Approach

Road traffic (busway) sound levels have been predicted using the Ministry of the Environment (MOE) noise prediction model, ORNAMENT, which is based on the technique developed by the U.S. Federal Highway Administration (FHWA) and enhanced by the Ministry of Transportation and the Ministry of the Environment.

The STAMSON program Version 5.04 (2000) was used for calculating all road and bus traffic sound levels based on analysis of multiple road sections/segments to further enhance its three-dimensional capabilities. STAMSON is the computerized version of the MOE's current noise prediction model, ORNAMENT.

The road traffic sound level calculations are primarily based on the average daily traffic volumes (AADT), percentages of medium and heavy vehicles, posted speed limits, road to receptor distance, elevation differential between the road and the receptor, roadway gradient, pavement type and the type of ground cover between the road and the receptor in question.

Based on MOE guidelines for predicting road traffic noise, the equivalent daytime sound level in dBA, Leq corresponding to the average hourly volume of the 16 hours traffic (07:00-23:00) was used for noise impact assessment , i.e. Leq_{16h} in dBA. For information purposes, the equivalent nighttime sound level in dBA, Leq_{8h} corresponding to the average hourly volume of the 8 hours traffic (23:00-07:00) was included in this study.

For BRT stations, stationary source assessment procedures were employed as was recommended by the MOE. The approach requires the assessment of hourly sound levels (i.e. Leq_{1h}).

Stationary sources sound levels assessed were predicted using an ISO-based prediction model developed by SS Wilson Associates. The stationary sound level calculations are based on reference sound emission levels of buses and cars, bus and car volumes, distance setbacks, acoustic shielding by barriers and other structures, ground and atmospheric attenuation, and grade elevations.

Noise measurements (attended: short term over a period of 4 hours and un-attended: long term over a period of 5 days) were carried out to establish the sound emission levels of buses and cars and the prevailing ambient sound levels. The short term attended measurements were used in the stationary source prediction model, while the long term unattended measurements were used to verify the predicted ambient sound levels due to road traffic.

For the purpose of this study, the environmental noise impact assessment is based on the change in sound levels above the future ambient sound levels.

2.2 Project Description

The BRT East system extends from Hurontario Street to Renforth Drive running alongside Eastgate Parkway and Eglinton Avenue West in the City of Mississauga.

BRT East will consists of ten BRT stations (City Centre/Hurontario; Central Parkway; Cawthra Road; Tomken Road; Dixie Road; Tahoe Boulevard; Etobicoke Creek; Spectrum Way; Orbitor Drive & Renforth Drive) and a busway connecting the stations. The busway is grade separated at Sherwoodtowne Boulevard, Central Parkway, Eastgate Parkway, Cawthra Road, Tomken Road, Dixie Road, Fieldgate Drive, Tahoe Boulevard, Eglinton Avenue West, Spectrum Way, Satellite Drive, Orbitor Drive, Explorer Drive and Commerce Boulevard.

The busway will be an exclusive, grade separated, two lane, bus-only roadway with stations that allow for integration with local road bus services. The stations will include such infrastructure items as GO Transit and Mississauga BRT platforms, local bus platforms, passenger drop-off areas, passenger shelters, waiting areas, pedestrian overpasses, concrete safety barriers, fencing, where required, parking facilities and access roads, elevators, stairs, etc.

Plans and profiles pertaining to the existing and proposed project conditions have been supplied by McCormick Rankin Corp.

Road and bus traffic data pertaining to the existing and proposed project conditions have also been supplied by McCormick Rankin Corp.

Appendix A includes the traffic data used in this study.

3.0 SOUND LEVEL CRITERIA

3.1 MOE SOUND LEVEL CRITERIA FOR BUS MOVEMENTS

At the present time, there are no provincial regulations or policies for the control of individual or cumulative bus sound levels operating on provincial or municipal roadways.

The only applicable provincial legislation is the Highway Traffic Act which requires all vehicles to be equipped with exhaust muffling devices. On the other hand, the Federal Government has published noise emission standards for new buses not to exceed 83 dBA at 15m when tested at the manufacturer's facilities.

The following summarizes the MOE noise criteria endorsed for the City of Mississauga BRT system (ref. MOE letter dated November 29, 1990):

1. Bus Movements Between Stations

The noise should be assessed on a 16/8 hour basis, 07:00-23:00 and 23:00-07:00. The criteria should be 55 dBA, day-time and 50 dBA, night-time, or the ambient in either period, which ever is higher. Control measures need be applied only if the excess is more than 5 dB.

2. Bus Stops

Simple bus stops do not have to be separated from the general noise produced by the moving buses.

3. Bus Stations

Bus stations are stationary sources and should be assessed in accordance with NPC-105 (now NPC-205, a copy of which is included in Appendix D). This implies assessment using 1 hour Leq and the limit being defined by the pre-existing ambient noise level.

3.2 MOE SOUND LEVEL CRITERIA FOR CONSTRUCTION EQUIPMENT

The Ministry of the Environment (MOE) Publications NPC-115 "Construction Equipment" and NPC-118, "Motorized Conveyances" deal with sound levels generated by construction equipment. These publications do not set overall combined sound level limits due to construction sites but set limits for noise generated by the individual pieces of equipment used on construction sites.

With respect to truck noise, the governing criteria are contained in the Federal Government safety test standards for manufacturing of new trucks included in

their publication titled “SECTION 1106-Noise Emission Tests for Motor Vehicles, and the relevant Consolidated Regulations of Canada, 1978 amended by SOP-179-115, September 1, 1979: Section 1106”. Typical trucks maximum sound emission level is 83 dBA for a vehicle gross weight of over 4500 kg.

3.3 APPLICABLE SOUND LEVEL CRITERIA

The following sound level criteria apply to all vehicular and bus traffic within the BRT system:

- The applicable sound level descriptor is the A-Weighted Equivalent Sound Pressure Level, Leq in dBA established for the daytime period from 07:00 to 23:00, also referred to as Leq16 hr, dBA. Nighttime period from 23:00 to 07:00 assessment of the noise impact will not be considered.
- The objective for outdoor sound levels when applying mitigation measures is the higher of the Leq16 hr 55 dBA or the future do-nothing ambient. Mitigation will attempt to achieve sound levels as close to these levels as is administratively, economically and technically feasible.
- The significance of a noise impact, also referred to as the ‘excess’ or ‘change’ will be quantified by comparing the future sound levels with the higher of the Leq16 hr 55 dBA and/or the future do-nothing ambient. The excess or change of the future sound levels relative to the existing ambient must also be determined.
- The degree of effort applied, and action for mitigation of the noise impact should conform to Table 1.
- Where the future sound level exceeds Leq16 hr 55 dBA and the increase in the sound levels above the future do-nothing ambient exceeds 5 dBA, the feasibility of noise control measures within the right-of-way will be investigated. Appropriate measures will be introduced such that, where feasible, a minimum attenuation (averaged over the first row of receivers) of 5 dBA can be achieved.

Additional considerations that must be incorporated are outlined below:

- To define the area of noise impact from the BRT, the smallest study area should be defined using one or more of the following methods:
  - Using 5 dBA contour lines extending from the source to a noise sensitive area where there is no increase above the ambient sound level;
  - A noise sensitive area where there is no increase above the ambient sound level;
  - A perpendicular distance of 200 m from the closest edge of pavement.
- The noise impact on noise sensitive areas is to be determined for outdoor spaces.
- There is no minimum number of residences that define a noise sensitive area. Therefore, all noise sensitive land uses, regardless of size or location, are to be assessed for application of noise control measures.

- The existing ambient sound levels will be based on the existing road and traffic information at the time of project initiation (in this study the existing traffic was based on year 2007).
- Future do-nothing ambient is the sound level 10 years after construction (in this study the future-do-nothing traffic was based on year 2017) of a Busway if no action had been taken to improve transportation facilities.
- Future sound levels from the project will be based on traffic projections to the horizon years of the project (in this study the future BRT traffic was based on year 2021).
- Off right-of-way noise control measures will not be considered.
- Impact assessment ratings may be interpreted based on Table 1.
- The sound levels will be established using prediction models acceptable to the City of Mississauga and Province of Ontario.
- Consideration must be given to the noise impacts of moving traffic on the BRT busway as well as stationary noise sources such as equipment and bus/car operations within the BRT stations.

4.0 ANALYSIS AND RESULTS

4.1 AMBIENT/BACKGROUND NOISE

Ambient noise used in the context of this report is the sound levels at the selected receptor locations without the additional noise generated by the BRT East system.

The existing ambient/background sound levels are due to vehicular traffic on the nearby highways/roadways in the area including Highway 403, Eastgate Parkway, Eglinton Avenue West, the intersecting arterial roads and the associated interchange ramps of Hwy 403. The following is a list of the transportation sources of noise considered in this study:

- Highway 403
- Eastgate Parkway
- Eglinton Avenue West
- Hurontario Street
- Central Parkway East
- Cawthra Road
- Tomken Road
- Dixie Road
- Renforth Drive

It should be noted that there are other major sources of transportation noise affecting the area of concern which were not included in the estimation of the ambient noise. The sources include aircraft and railway noise which were specifically excluded from the analysis in order to comply with the MOE recommendation for the exclusion of sources of noise that are fairly intermittent in nature.

Ambient noise due to vehicular traffic movements on the above-noted highways/roadways were calculated using the MOE ORNAMENT noise prediction model (STAMSON Version 5.04(2000)) based on the road traffic data supplied by McCormick Rankin Corp.

The predicted day and night ,i.e. Leq(16h) and Leq(8h) ambient sound levels are listed in Table 4.1 (existing ambient)/(future-do-nothing ambient) and in Table 4.2 (existing ambient), while the predicted hourly day, evening and night (i.e. Leq(1h)) ambient sound levels are listed in Table 4.3.

Appendix A contains the road traffic data used for the ambient noise calculations, while Appendix C includes sample ambient noise calculations.

4.2 POINTS OF RECEPTION

Points of reception are considered any point on the premises of a person where sounds originating from other than the premises are received.

For the purposes of this study, twenty six locations were selected to represent the closest points of reception to both the busway and stations, which may potentially be affected by noise. The receptor heights were taken at Outdoor Living Areas (OLA's) when calculating the BRT busway sound levels and at typical first and second storey windows when calculating the BRT stations sound levels.

The following gives a brief description of the selected receptors (denoted Re1 to Re26):

Residential Receptors

Re1 Apartment building on Tucana Court.
Re2 Townhouse on Porto Fino Place.
Re3 Apartment building on Acorn Place.
Re4 House #292 Laurentian Avenue.
Re5 House #446 Aberfoyle Court.
Re6 House along Sagamore Circle.
Re7 House on Bigham Crescent.
Re8 House #1713 Chalkdene Grove.
Re9 House #1685 Copseholm Trail.
Re10 House #1507 Bough Beeches Boulevard.
Re11 House #4384 Poltava Crescent.
Re12 House #1311 Underwood Drive.
Re13 House #1199 Highgate Place.
Re14 House #4402 Lee Drive.
Re15 House #4404 Shelby crescent.
Re16 House #4336 Forest Fire Lane.
Re17 House #4329 Wilcox Road.
Re18 House #4328 Curia Circle.
Re19 Townhouses #385-405 Rathburn Road.
Re20 House #4331 Alta Court.
Re21 House #217 Chalfield Lane.

Commercial Receptors

Re22 Commercial building at south-east corner of Sherwoodtowne Boulevard and Highway 10.
Re23 Commercial building at south-east corner of Tahoe Boulevard and Eastgate Parkway.
Re24 Commercial building at north of intersection of Tahoe Boulevard and

Eglinton Avenue West.

Re25 Commercial buildings at north of intersection of Orbitor Drive and Eglinton Avenue West.

Re26 Centennial Centre, 2 storey commercial buildings along the south side of Eglinton Avenue West between Commerce Boulevard and Renforth Drive.

Figures 2.1 to 2.12 show the locations of the selected receptors.

Photographs 1 to 24 show different views of the study area and surroundings.

4.3 DESCRIPTION OF THE NOISE SOURCES

The primary sources of noise associated with the proposed BRT system are bus movements operating on the bus lanes and all bus activities within the stations. Other sources of noise of lesser magnitude include automobile traffic using the designated parking areas associated with the stations and possibly mechanical equipment associated with the stations. The noise emitted by buses is due to bus exhaust, engine and tire/ground interaction depending on the bus speed and the type of pavement.

Since noise prediction methodologies for buses moving on a roadway or within a station are different, the description of the specific bus activities and associated sound levels will be dealt with separately.

1. In-Between Stations

At Ground Level

Buses are expected to operate between stations at up to 90 km/h, except near the stations where buses will be accelerating and decelerating.

The traffic noise prediction model used for the assessment of bus movements between the stations is the MOE noise prediction model “ORNAMENT” (STAMSON Version 5.04(2000)).

For this analysis, no other sources of noise were considered along the busway since buses are the predominant part of vehicular traffic allowed within the BRT system corridor.

In Cut Sections

The BRT corridor is planned to be in a retained (i.e. below grade) cut at a limited number of sections along the proposed alignment as summarized below:

- Proximity to residential:

- 100m near Fieldgate Drive

- Proximity to Offices:
  - 10m near Sherwoodtowne Boulevard
  - 40m near Tahoe Boulevard
  - 25m near Bell Mobility Offices
  - 20m near Orbitor Drive

When buses travel in cut sections, they will be totally/partially shielded depending on the geometry of the intervening lands between the BRT lanes and the receptors. This acoustic shielding effect will reduce the bus sound levels. On the other hand, when buses travel in cut sections there will be multiple reflections “reverberations” as a; result of the presence of hard/reflecting walls. These reverberations will increase the bus sound levels. When the effects of both acoustic shielding and reverberations are taken into account, the overall result

A typical section where the possible acoustic effects may develop is shown in Figure 3.1, where the right-of-way is restricted. Other sections may include an underpass below other existing roadways.

For bus movements along the BRT busway in a retained cut, sound waves reflect back and forth across the alignment one or more times before ultimately progressing outwards towards nearby receptors. These multiple reflections have the potential to increase the sound levels at certain points of reception, depending on the geometry of the situation.

While cut sections, in general, are sometimes considered as sound barriers as a result of their ability to diffract the sound waves around their edge(s), the added reflected sound waves create a reverberant sound field thus resulting in higher sound levels which may offset the noise reduction due to the sound barrier effect created by the cut section.

For receptors further away from deep cuts, the net result is minor reduction in the sound levels and further away from shallow cuts, the net result is minor increase in the sound levels. For close-by receptors, the net result is a noticeable increase in the sound levels for both deep and shallow cuts.

For elevated receptors, near and far, the net result is always a noticeable increase (in the order of 4 to 6 dBA) in the sound levels in addition to prolonged exposure to the noise signal and the possible change of the character of noise to be that of an echo.

Therefore, the terms “net result”, “net effect”, “effect” and “added effect” refer simply to the fact that both cut section effects (i.e. acoustic shielding and reverberations) are accounted for in the calculations of bus sound levels while traveling below grade in cut sections.

The foregoing findings are based on the assumption that the surfaces of the cut section are hard reflecting such as with the use of concrete and asphalt with nearly vertical side walls.

Figure 3.2 illustrates a typical BRT section in a cut that is in the order of 3-4m high and typical multiple reflection paths; single and double reflected sound rays and potential for sound barrier effect.

A ray tracing and energy integrating sound level prediction model has been developed to model typical cross-sections along the proposed BRT alignment where noise-sensitive receptors exist. The model took into account the paths of the primary noise signal as well as four (4) reflected sound rays with single and two reflections. Based on this analysis, the following is concluded:

- For residential receptors at 100+m, the added net effect is up to 4 dBA for ground floor receptors. For higher floors, the effect is up to 5 dBA.
- For office receptors at 10-25m, there is no expected sound level reduction and the added effect is up to 6 dBA depending on the receptor height in the offices.

For simplification purposes, a correction factor of +5 dBA has been added to the predicted BRT free-field traffic at all receptors of concern affected by the noted cut sections.

In summary, for all BRT cut sections, an adjustment factor of +5 dBA is manually added to the corresponding STAMSON segments. For BRT sections at ground level, no adjustments were added to the corresponding STAMSON segments. The +5dBA adjustment used in the prediction of the future BRT sound levels has nothing to do with BRT daily/hourly traffic volumes.

2. Within the Stations

The primary sources of noise within a bus station are due to a variety of bus activities and movements within the designated areas of the stations where buses accelerate, decelerate, idle and move at constant speeds. Such activities generate different sound levels and the time or duration of each event varies. Since the ORNAMENT model cannot deal with such complex evaluations, a different approach was followed whereby the sound emission levels of buses operating under different conditions were actually measured in Mississauga and the results were then used to compose overall noise exposure levels at the specific points of reception.

Bus sound level measurements were taken recently within the City of Mississauga's Transit Garage located at 975 Central Parkway West. The

measured bus sound emission levels were used in the subsequent calculations of the bus station sound levels.

Sound levels due to bus activities within the bus stations were calculated using an ISO based 3-D computer program developed by SS Wilson Associates for multiple receptors and multiple noise sources. The program takes into account the following factors:

- Reference sound levels and reference distances for the various bus movements or activities.
- Reference sound levels for vehicular traffic activities within the parking area.
- Volume of buses.
- Divergence (distance) attenuation.
- Sound barrier attenuation, where applicable.
- Ground and Atmospheric attenuation (as modified by source/receiver elevations and the intervening sound barrier).
- Source and receptor elevations.

The predicted day and night (i.e. Leq(16h) and Leq(8h)) overall future sound levels including the BRT bus lane sound levels are listed in Table 4.2, while the predicted hourly day, evening and night (i.e. Leq(1h)) BRT bus station sound levels are listed in Table 4.3.

Appendix A contains the bus traffic data used for bus noise calculations, while Appendix C includes sample bus noise calculations.

The BRT Bus volumes used are based on the horizon year 2021 as listed in the last two sheets (tables) in Appendix A. The bus activity at BRT Stations Table (second last sheet in Appendix A) lists bus volumes (stopping/through/terminating) for 24 hr/day/evening/night periods. The BRT station peak hour volumes listed in columns 5 to 7 (from the left) were used for the daytime peak period of 7 a.m. – 10 a.m., while the evening peak hour (7 p.m. – 8 p.m.) was based on 35% of the entire evening period volume and the night peak hour (6 a.m. – 7 a.m.) was based on 30% of the entire night period volume as advised by MRC.

The Bus volumes on BRT Links (2021) Table (last sheet in Appendix A) includes 24 hour bus volumes for the horizon years 2014 and 2021 as well as day (12 hr)/evening 4 hr)/night (8 hr) bus volumes for the horizon year 2021. The bus volumes corresponding to the horizon year 2021 are used in this Noise Report.

Since no detailed station plans are available at this time to show the design of the specific station where a station building will be constructed, the noise from any potential mechanical equipment such as ventilation fans and air

conditioning equipment was not considered at this point. It is worth noting that the noise from mechanical equipment are expected to be lower than the noise generated by the bus/car movements and also due to the present of high ambient/background sound levels.

4.4 SOUND LEVEL MEASUREMENTS

General

Short term (attended) bus and long term (un-attenuated) ambient sound level readings were taken during the course of preparation of this noise study.

The scope of bus noise measurements was to conduct actual field testing of the sound levels emitted by the City of Mississauga buses when operated under normal operating conditions for the purpose of estimating the overall sound levels generated by the busway and stations. The bus sound levels measured may be considered as sound emission levels for buses performing different operations such as idling, accelerating, decelerating, etc.

The scope of the ambient noise measurements was to conduct actual field testing to confirm the accuracy of the predicted ambient noise level in order to support and enhance the calculated levels and indicate if and where anomalies exist in the prediction model.

Instrumentation

The attended bus sound level measurements were performed using the following equipment:

- Rion NA-28 & NA-27, Type 1 Precision Integrating Sound Level Meters and Real Time Frequency Analyzers fitted with 1/1 & 1/3 Octave Bands filters and 1/2” condenser microphones c/w windscreen and mounted on tripods.
- Bruel & Kjaer Precision Calibrator Model B&K 4231.

The unattended ambient sound level measurements were performed using the following equipment:

- Three Rion NL-22 Integrating Sound Level Meters fitted with 1/2” condenser microphones c/w windscreens. The sound level meters were contained in weather-protected environmental casings.
- Bruel & Kjaer Precision Calibrator Model B&K 4231.
- Ancillary field equipment including tripods and telescopic poles

Procedures

The sound level measurement procedures were primarily based on the Ministry

of Environment procedures in their Publication NPC-103 “Procedures”, the recommendations of the instrument manufactures and the best engineering practices to suit site specific conditions. The sound level meters were checked and calibrated before and following completion of the measurement sessions without any appreciable change in the sound levels.

The weather conditions during the measurement sessions were favourable for measurements as the local wind speed did not exceed 15 km/hr and there was no precipitation.

The attended bus measurements were carried out on Friday, September 28 and Friday, October 3, 2007, while the un-attenuated ambient measurements were carried out from September 22 to 26, 2008.

Locations

The following gives a brief description of the sound level measurements locations:

Attended Bus Measurements

The measurements were conducted within the City of Mississauga Transit Garage located at 975 Central Parkway West at set distance setbacks of 10m from bus moving lane and of 7.5m from bus idling lots.

The buses tested included typical vehicles of the Mississauga Transit fleet that will be used on the BRT corridor including articulated vehicles due to their potential for higher sound levels.

Unattended Ambient Measurements

Three locations were selected for noise measurements. The measurement locations are taken at receptors Re6, Re11 and Re16.

Location Re16 represents residences located south of the proposed Cawthra Road bus station, location Re11 represents residences located south of the proposed Dixie Road bus station, and location Re6 represents residences/commercial buildings located south of the proposed Renforth Drive bus station.

Table 2 includes a summary of the logarithmically averaged bus and car sound levels, which were used for sound level modeling in this report.

Table 3.1 lists the measured daytime (averaged over a 15 hour period from 7 a.m. to 11 p.m.) and nighttime (averaged over an 8 hour period from 11 p.m. to 7 a.m.) ambient sound levels. Table 3.2 lists the measured lowest hourly ambient

sound levels for the day (3 hour period of 7 a.m. to 10 a.m.), evening (1 hour period 7 p.m. – 8 p.m.) and night (1 hour period 6 a.m. to 7 a.m.). the day/evening/night time periods referenced in Table 3.2 coincide with the BRT stations peak activity hours, which were used in the stationary noise impact assessment. When the Leq (8h) nighttime sound levels listed in Table 3.1 are compared with the Leq (1h) nighttime sound levels, the latter levels are higher than the former levels due to the fact that vehicular traffic during the early morning hours of 6 a.m. to 7 a.m. is higher than the hourly vehicular traffic when averaged over the whole 8 hour nighttime period of 11 pm. To 7 a.m.

Figures 2.3, 2.5 and 2.8 show the unattended ambient noise measurement locations.

Appendix B includes the noise measurement results.

4.5 RESULTS

The overall existing sound levels were found to be largely due to vehicular traffic on the existing Highway 403, interchange ramps and arterial roads.

The measured existing day and night ambient sound levels are in the range of Leq (16h) 49 to 62 dBA day and 51 to 60 dBA night (ref. Table 3.1).

The measured lowest existing hourly ambient sound levels are Leq(1h) 45 to 61 dBA day, 48 to 60 dBA evening and 54 to 63 dBA night (ref. Table 3.2).

Sound levels were predicted due to three different noise sources:

1. Bus traffic along the Busway.
2. Activities within the stations. This includes local and BRT buses entering into, existing from, maneuvering and idling within the station boundaries as well as cars entering into, existing from and idling within the Kiss & Ride and Park & Ride Facilities (where applicable).
3. Vehicular traffic on the existing Highway 403, interchange ramps and arterial roads. These constitute the sources of ambient sound levels.

The predicted existing ambient sound levels are in the range of Leq (16h) 50 to 65dBA day (residential receptors) and 64 to 72 dBA (commercial receptors) (ref. Tables 4.1 and 4.2).

The predicted future ambient sound levels are in the range of Leq (16h) 51 to 67dBA day (residential receptors) and 65 to 73 dBA (commercial receptors) (ref. Table 4.1).

The predicted future overall project sound levels (including the BRT system) are in the range of Leq (16h) 52 to 67dBA day (residential receptors) and 68 to 75

dBA (commercial receptors) (ref. Table 4.2).

The predicted lowest existing hourly ambient sound levels are Leq(1h) 49 to 65dBA day, 48 to 64dBA evening and 46 to 64dBA night, while the predicted highest hourly future BRT station sound levels are Leq(1h) <40 to 53dBA day, <40 to 51dBA evening and <40 to 46dBA night (ref. Table 4.3).

Table 5.1 includes comparisons between the measured and predicted average day and night ambient sound levels, while Table 5.2 includes comparisons between the measured and predicted lowest hourly day, evening and night ambient sound levels. The reported sound level differences can be attributed to several factors including but not limited to differences in traffic volumes, traffic compositions, traffic speeds, extraneous sources, inclement/favourable meteorological conditions, etc., between the measured and predicted levels.

The comparisons show differences of 1 to 4 dBA during the day between the measured and predicted sound levels. These differences are considered to be acoustically insignificant to noticeable and are attributed to variations in the road traffic volumes/compositions used in the predictions and the one measured in the field and to the presence of external noise sources that could not be accounted for in the prediction model. Therefore, the use of the predicted levels in this study is considered as being more consistent for noise impact assessment purposes.

It should be noted that the hourly ambient sound levels are only used in the establishment of the applicable sound level criteria for the stationary noise impact assessment of BRT stations (ref. MOE Publication NPC-205).

With regards to the listed ambient sound levels, we offer the following additional comments and explanations:

- Receptor Re6 is located at a considerable distance setback from the proposed Renforth Drive BRT Station. The predicted hourly BRT Station sound levels are Leq (1h) 46 dBA day/<46 dBA evening/<45 dBA night. These sound levels are less than the Exclusion Limits (i.e. the minimum ambient levels) of Leq (1h) 50 dBA day/47 dBA evening/45 dBA night set by the MOE for this study area [this study area Class 1 Area (Urban)]. Therefore, it is irrelevant which set of hourly ambient levels is used as both sets are higher than the MOE Exclusion Limits.
- Receptor Re11 is physically shielded by an earthen berm located south of Eastgate Parkway between Dixie Road and Fieldgate Drive) from the proposed Dixie BRT Station. The predicted hourly BRT station sound levels are Leq (1h) <53 dBA day/<51 dBA evening/<46 dBA night. These sound levels are less than the measured and predicted hourly ambient sound levels. Therefore, the noise impact assessment/results will not be affected as both ambient sound level sets are higher than the BRT station sound levels.
- Receptor R16 is physically shielded by an earthen berm (located south of Eastgate Parkway between Cawthra Road and Tomken Road) from the

proposed Cawthra BRT station. The predicted hourly BRT Station sound levels are Leq (1h) <40 dBA day/<40 dBA evening/<40 dBA night. These sound levels are less than the Exclusion Limits (i.e. the minimum ambient levels) of Leq (1h) 50 dBA day/47 dBA evening/45 dBA night set by the MOE for this study area [Class 1 Area (Urban)]. Therefore, it is irrelevant which set of hourly ambient levels is used as both sets are higher than the MOE Exclusion Limits.

Based on the above reasoning, it is equally valid to use either sets of hourly ambient sound levels. However, in the March 15, 2009 Noise Report, the predicted hourly/daily/nightly ambient sound levels are used for noise impact assessment purposes as they yield more consistent data.

4.6 IMPACT ASSESSMENT

In impact assessment of highway projects, in general the MOE recommends comparing the predicted future sound levels of the undertaking with the existing ambient sound levels and/or the future-do-nothing without the undertaking sound levels. The degree of change between any two sound levels reflects the significance of the impact, whether an increase in the level (undesirable) or a decrease in the level (desirable). In addition, the magnitude of the change is also important in assessing how the public would react, in general, to the increased or decreased highway noise levels.

For this project, a new dimension has been added, which is the BRT noise component as it relates to the existing ambient due to Highway 403, interchange ramps and arterial roads. The latter noise is also subject to change from existing to future conditions with the natural increase in highway/roadway traffic without the BRT component. The existing Highway 403, interchange ramps and arterial roads traffic is a dynamic element, which is expected to also increase with or without the BRT system.

Accordingly, the impact assessment methodology followed in this study relied on the following:

(i) For receptors located along the BRT route, the impact is assessed for Outdoor Living Areas (OLA's) and is based on the following:

- Comparing the future sound level including the BRT noise component with the future sound level excluding the BRT noise component.
- For information purposes, we are providing a comparison of the future sound level including the BRT system component noise with the existing ambient sound level, which represents the actual magnitude of the change in sound level the general public will be exposed to due to the combined effect of the future road noise and the BRT system noise. While this comparison is factual, it does not represent the potential change due to

the BRT system noise and accordingly, was not used for decision making purposes.

(ii) For receptors located in proximity to the BRT stations (not bus stops), the impact is assessed at the first and second storey windows on the most exposed building façades of the residential dwellings and is based on comparing the future (worst case scenario) BRT station noise levels with the higher of the existing highway/roadway ambient noise level or the minimum exclusionary sound level limits set by the MOE for urban Class 1 areas similar to the one under consideration.

The data included in Tables 4.1 and 4.2 show that the ambient and future sound levels at most of the selected receptors are higher than the MOE/Region/City day-time Leq 55 dBA objective.

The data included in Table 4.2 show that the calculated excesses of the future sound levels over the ambient levels are up to 4 dBA (i.e. acoustically noticeable) at the residential receptors and up to 6 dBA (i.e. acoustically significant) at the commercial receptors. The calculated excesses are within the maximum 5 dBA excess criterion at the residential receptors, but are over the maximum 5 dBA excess criterion at the commercial receptors.

The data included in Table 4.3 show that in the case of the station activities, there is no calculated excess sound level over the ambient, i.e. the station sound levels are predicted to be within the applicable criteria.

4.7 MITIGATION

For bus movements along the BRT busway, mitigation is warranted if the excess of the future sound levels above the ambient is greater than 5 decibels in the Outdoor Living Areas (OLA's).

For bus/car operations within the BRT stations, mitigation is warranted if the future sound levels exceed the higher of the existing ambient levels or the MOE exclusionary limits for urban Class 1 areas. (MOE Class 1 Area means an area with an acoustical environment typical of a major population centre, where the background noise is dominated by the urban hum).

The purpose of mitigation, when introduced is to reduce (as administratively, economically and technically feasible) the predicted future project noise levels to the objective level. The objective level is the higher of ambient noise level or Leq (16h) 55 dBA in the case of bus movements along the BRT busway and the higher of ambient noise level or Leq (1h) 50 dBA day/47dBA evening/45dBA night in the case of bus/car activities within the BRT stations.

In accordance with the applicable sound level criteria, no noise mitigation is

warranted at all the residential receptors (Re1 to Re21) and two commercial receptors (Re22 and Re26) since the noise impact due to the BRT Busway is predicted to be less than 5 dBA and the noise impact due to the BRT stations is predicted to be within the prevalent ambient noise.

For three commercial receptors (Re23, Re24 and Re25), noise mitigation is warranted since the noise impact due to the BRT Busway is predicted to be more than 5 dBA due to the placing of the BRT corridor in a retained (i.e. below grade) cut.

Possible noise control measures include the use of sound absorbing wall finishes (panels capable of providing minimum absorptive co-efficient of 0.6 at 250 Hz and progressively higher values at higher frequencies and/or plantings) and/or side walls on outward slopes, which can reduce or eliminate the added effects of multiple reflections/reverberations. The sound absorbing wall finish is recommended to be installed to cover not less than 80% of the retained cut wall areas and shall have the following extents:

- Re23 at Tahoe Boulevard/Eastgate Parkway: 120m north/120m south of Tahoe boulevard centre line at Eastgate Parkway
- Re24 at Tahoe Boulevard/Eglinton Avenue West: 75m east/75m west of Tahoe boulevard centre line at Eglinton Avenue West
- Re25 at Orbitor Drive/Eglinton Avenue West: 120m east/120m west of Orbitor Drive centre line at Eglinton Avenue West

Figures 4.1 to 4.3 show different wall cut acoustic treatment concepts.

5.0 FINDINGS AND RECOMMENDATIONS

5.1 FINDINGS

This study has been carried out to research all aspects related to the potential noise impact of the BRT system on the nearby noise-sensitive areas which also include nine bus stations. The study dealt with documentation of the existing ambient conditions, the applicable criteria, the future sound levels and noise control measures, where warranted. The study has found that:

1. Vehicular traffic on Highway 403, interchange ramps and arterial roads is considered as the major source of environmental ambient noise within the study area.
2. The predicted sound levels at most of the residences prior to undertaking of the BRT system do exceed the Provincial/Region/City objective of Leq 16 hours 55 dBA due to their close proximity and wide exposure to the existing network of highways and roads. For existing residences (i.e. all residences within the study area), outdoor noise control measures are not warranted if the Outdoor Living Areas sound levels exceed 55dBA.
3. The established excess sound levels due to the BRT system over the existing and future-do-nothing ambient sound levels at all residences are predicted to be no greater than 4dBA; i.e. within the maximum allowable excess of 5 dBA.
4. The established excess sound levels due to the BRT system over the existing and future-do-nothing ambient sound levels at three commercial/office buildings are predicted to be up to 6dBA; i.e. over the maximum allowable excess of 5 dBA.
5. The BRT alignment has been selected in areas that are dominated by noise from well established arterial roads and Highway 403; i.e. the alignment is acoustically compatible with the existing land uses.

5.2 RECOMMENDATIONS

In accordance with MOE Condition of Approval #3, the following recommendations are made in keeping with the 1991 Noise Report:

1991 Noise Report Recommendations	Preliminary Design Recommendations
1. The noise impact due to ultimate bus traffic on the proposed Busway system is considered minor with respect to all locations along the proposed alignment since the increase in sound levels due to bus traffic on the proposed Busway would	Recommendation verified during this assessment for all residential properties. For three commercial/office buildings, the Busway noise impact due to buses traveling in retained cuts is

be a maximum of 5 dBA. This increase is within the MOE/MTO acceptable Protocol criteria for new and expanded roadway projects. Accordingly, additional noise control measures are NOT required.	predicted to exceed 5 dBA. The predicted increases are over the MOE/MTO acceptable Protocol criteria for new and expanded roadway projects. Accordingly, additional noise control measures are required.
2. In the case of the receptors located in the vicinity of the proposed stations, the overall combined noise impact is also considered minor with respect to all proposed stations, and additional noise control measures are also NOT warranted.	Recommendation verified during this assessment
3. To meet the MOE requirements for stationary noise sources during the construction phase of the proposed undertaking, construction equipment used on the site should meet the sound emission level standards set by the MOE. The MOE assesses noise impact during the construction period against the sound level standards set out in Publications NPC-115 and NPC-118 (see Appendix D). These standards limit the allowable levels from the equipment at source rather than at the receiver. In order to meet the above requirements, the equipment will have to be certified by the manufacturer. If such certification is not available or if the equipment is not new, it will be required that the proponent certifies that the actual equipment used based on “on-site” measurements, under typical operating conditions comply with the MOE requirements. Other relevant standards include the Federal Government Standards regulating the noise emissions from heavy and medium trucks.	Recommendation verified during this assessment The following Federal and Provincial Government Standards will be mat for this project: - Noise Emissions (Standard 1106) - NPC-115 (Construction Equipment) - NPC-118 (Motorized Conveyances) Appendix D includes copies of these Standards.

4. To improve the acoustical performance of the proposed Busway cuts we recommend that the wall construction materials have reasonable sound absorptive qualities and/or by constructing the cut sidewalls using an outward slope or slant. These measures will improve both the noise perceived at the near-by receptors, the transit system riders	Recommendation verified during this assessment Possible noise control measures include the use of sound absorbing wall finishes (panels capable of providing minimum absorptive co-efficient of 0.6 at 250 Hz and progressively higher values at higher frequencies and/or plantings) and/or side walls on outward slopes, which can reduce or eliminate the added effects of multiple reflections/reverberations. The sound absorbing wall finish is recommended to be installed to cover not less than 80% of the wall areas and shall have the following extents: - BRT underpass at Tahoe Boulevard/Eastgate Parkway: 120m north/120m south of Tahoe boulevard centre line at Eastgate Parkway - BRT underpass at Tahoe Boulevard/Eglinton Avenue West: 75m east/75m west of Tahoe boulevard centre line at Eglinton Avenue West - BRT underpass at Orbitor Drive/Eglinton Avenue West: 120m east/120m west of Orbitor Drive centre line at Eglinton Avenue West

Monitoring

In accordance with an MOE Condition of Approval for the EA Addendum, the following outlines commitments to noise monitoring:

- Sound level monitoring of the existing ambient shall be carried out in advance of construction and following Transitway operations at the residences near the Cawthra Road, Dixie Road and Renforth Drive BRT stations. Monitoring shall be carried out continuously (24 hours, on hourly basis) over a minimum period of 5 days to include 3 weekdays, Saturday and Sunday at typical points of reception that are expected to receive the highest impact.
- Monitoring shall be based on the Ministry of Environment Publications NPC-

102 “Instrumentation” and NPC-103 “Procedures” (copies included in Appendix D).

- A noise monitoring report shall be prepared to contain all the relevant data and in accordance with the relevant technical requirements included in MOE Publications NPC-133 “Guidelines on Information Required for the Assessment of Planned Stationary Sources of Sound) and NPC-134 “Guidelines on Information for the Assessment of Planned New Land Uses with respect to Sound and Vibration Impacts” (copies included in Appendix D).
- Noise monitoring reports will be submitted to Transport Canada at appropriate intervals during construction.
- It is possible that the monitoring may identify noise effects that will warrant a review of the application of new noise mitigation measures. Should mitigation be warranted a review of appropriate noise control measures will be completed with consideration given to the technical, administrative and economic feasibility of the various mitigation alternatives.
- The monitoring plan will be refined and finalized in advance of construction and in consultation with MOE.

Construction Noise

Worst-case construction noise levels have the potential to be very loud during some short periods of time. However, noise effects from construction are relatively short compared to operational noise effects, and therefore, they are usually better tolerated by the community at large. As previously noted, the closest sensitive receptors are residences along Audubon Boulevard, Copseholm Terrace, Curia Crescent, Rathburn Road East/Meadows Boulevard between Curia Crescent and Central Parkway East, Alta Court and Chalfield Lane and commercial buildings along Orbitor Drive/Eglinton Avenue West, Tahoe Boulevard/Eglinton Avenue West and Tahoe Boulevard/Eastgate Parkway. There are no other sensitive receptors (e.g. hospitals, daycares, seniors residences) in such close proximity to the alignment.

The following provides an overview of typical construction equipment sound levels.

EQUIPMENT DESCRIPTION	SOUND LEVEL dBA at 15 m Reference Distance
Idling Truck	73
Trucks Unloading	78
Truck Movement	83
Bulldozer	85
Front End Loader	85
Chain Saw	78
Scraper	88
Roller	80
Backhoe	85

EQUIPMENT DESCRIPTION	SOUND LEVEL dBA at 15 m Reference Distance
Crane	83
Diesel Generator	78
Grader	85
Compactor	74
Curb Machine	89
Concrete Truck (Unloading)	73
Cable Trencher	85
Asphalt Machine	74
Jack Hammer	85
Compressor	85

With the application of the following noise mitigation, it is not anticipated that there will be significant adverse noise effects during construction:

- Restricting noisy activities to daytime hours where possible;
- Adhering to the City of Mississauga's Noise Control By-law; and
- Implementing the noise control procedures during construction.

To minimize the potential for construction noise effects, the following provisions will be written into the contract documentation for the contractor.

- General construction will be limited to the time periods outlined in the City of Mississauga's Noise Control By-law. If construction activities are required outside of these hours, exemptions will be sought in advance by the contractor, directly from the City of Mississauga.
- There will be explicit indication that contractors are expected to comply with all applicable requirements of the contract and local noise by-laws. Enforcement of noise control by-laws will be the responsibility of the City of Mississauga for all work done by contractors.
- All equipment will be properly maintained to limit noise emissions in compliance with MOE NPC-115 guidelines. As such, all construction equipment will be operated with effective muffling devices that are in good working order.
- The contract documents will contain a provision that any initial noise complaint will trigger verification that the general noise control measures agreed to be in effect.
- In the presence of persistent noise complaints, all construction equipment will be verified to comply with MOE NPC-115 guidelines.
- In the presence of persistent complaints and subject to the results of a field investigation, alternative noise control measures may be required, where reasonably available. In selecting appropriate noise control and mitigation measures, consideration will be given to the technical, administrative and economic feasibility of the various alternatives.
- Construction mitigation alternatives include but are not limited to:

    - Re-scheduling of noisy operations to daytime hours, where possible;
    - Use of alternate, quieter equipment or methods, where available; and
    - The use of portable, localized noise barriers for critical areas.
- The monitoring program (discussed above) will be implemented to monitor for potential effects due to construction noise. The noise monitoring program requirements will be identified during Detail Design and MOE will be consulted as necessary in the development of the program.
- Noise monitoring reports will be submitted to Transport Canada at appropriate intervals during construction.

Maintenance Noise

Worst-case maintenance noise levels have the potential to be very loud during some short periods of time. However, noise effects from maintenance activities are relatively short compared to operational noise effects, and therefore, they are usually better tolerated by the community at large.

With the application of the following noise mitigation, it is not anticipated that there will be significant potential noise effects during future maintenance activities:

- Restricting noisy activities to daytime hours where possible; and
- Adhering to the City of Mississauga's Noise Control By-law and seeking and obtaining exemptions as warranted.

TABLES

TABLE 1
SUMMARY OF NOISE IMPACT RATING AND ACTION FOR MITIGATION

Future Sound Level, $Leq_{16\ hr}$	Change Above Future Do-Nothing Ambient, dBA	Impact Rating	Mitigation
Equal to or greater than 55 dBA and less than 65 dBA	0 - 3	Insignificant	None
	3 - 5	Noticeable	None
	>5 - 10	Significant	Investigate noise control measures and mitigate to achieve criteria (minimum attenuation is 5 dBA)
	10 +	Very Significant	Investigate noise control measures and mitigate to achieve criteria (minimum attenuation is 5 dBA)
Greater than 65 dBA	0 – 3	Insignificant	Investigate noise control measures and mitigate to achieve criteria (minimum attenuation is 5 dBA)
	3 – 5	Noticeable	Investigate noise control measures and mitigate to achieve criteria (minimum attenuation is 5 dBA)
	>5 – 10	Significant	Investigate noise control measures and mitigate to achieve criteria (minimum attenuation is 5 dBA)
	10 +	Very Significant	Investigate noise control measures and mitigate to achieve criteria (minimum attenuation is 5 dBA)

Note: Mitigation efforts are subject to administrative, economical and technical feasibility.

TABLE 2
SUMMARY OF BUS AND CAR SOUND EMISSION LEVELS

Activity	Sound Emission Level
Bus Moving (slow speed)	73 dBA @ 10m
Bus Idling (normal idle)	71 dBA @ 7.5m
Car Moving (slow speed)	60 dBA @ 15m
Car Idling (normal idle)	56 dBA @ 7.0m

TABLE 3.1
MEASURED DAY AND NIGHT AMBIENT SOUND LEVELS

Location	Day Leq (16h)	Night Leq (8h)
Re6	61 to 62 dBA	59 to 60 dBA
Re11	56 to 57 dBA	54 to 55 dBA
Re16	49 to 54 dBA	51 to 52 dBA

TABLE 3.2
MEASURED LOWEST HOURLY AMBIENT SOUND LEVELS

Location	Day Leq (1h)	Evening Leq (1h)	Night Leq (1h)
Re6	61 dBA	60 dBA	63 dBA
Re11	56 dBA	54 dBA	57 dBA
Re16	45 dBA	48 dBA	54 dBA

Notes

(1) MOE time periods:

- Day: 7am -7pm
- Evening 7pm-11pm
- Night:11pm-7am

(2) Time periods used in this study to coincide with BRT station peak hours:

- Day: 7am-10am
- Evening: 7pm-8pm
- Night: 6am-7am

TABLE 4.1
ENVIRONMENTAL NOISE IMPACT ASSESSMENT
BRT EAST
WITHOUT BUSWAY
CITY OF MISSISSAUGA

Receptor Code	Receptor Name	Existing Sound Levels dBA	Future Sound Levels dBA	Excess Criteria for mitigation dBA	Future Sound Levels Minus Existing Sound Levels	Significance of the Change due to the Future Sound Levels Minus Existing Sound Levels	Noise Control measures As per Protocol
Re1	Without BRT	62.3	63.9	5	2	Insignificant	Not required
Re2	Without BRT	63.2	65.2	5	2	Insignificant	Not required
Re3	Without BRT	63.0	64.2	5	1	Insignificant	Not required
Re4	Without BRT	63.6	65.2	5	2	Insignificant	Not required
Re5	Without BRT	62.8	64.4	5	2	Insignificant	Not required
Re6	Without BRT	59.2	60.3	5	1	Insignificant	Not required
Re7	Without BRT	50.0	51.1	5	1	Insignificant	Not required
Re8	Without BRT	55.7	56.8	5	1	Insignificant	Not required
Re9	Without BRT	53.9	55.1	5	1	Insignificant	Not required
Re10	Without BRT	54.4	55.4	5	1	Insignificant	Not required
Re11	Without BRT	54.2	54.8	5	1	Insignificant	Not required
Re12	Without BRT	54.5	55.6	5	1	Insignificant	Not required
Re13	Without BRT	52.5	53.5	5	1	Insignificant	Not required
Re14	Without BRT	53.6	54.5	5	1	Insignificant	Not required
Re15	Without BRT	52.9	54.0	5	1	Insignificant	Not required
Re16	Without BRT	53.3	54.4	5	1	Insignificant	Not required
Re17	Without BRT	61.6	63.2	5	2	Insignificant	Not required
Re18	Without BRT	64.1	65.7	5	2	Insignificant	Not required
Re19	Without BRT	64.5	66.2	5	2	Insignificant	Not required
Re20	Without BRT	65.2	66.9	5	2	Insignificant	Not required
Re21	Without BRT	64.6	65.3	5	1	Insignificant	Not required
Re22	Without BRT	72.1	73.3	5	1	Insignificant	Not required
Re23	Without BRT	63.9	65.0	5	1	Insignificant	Not required
Re24	Without BRT	64.2	65.3	5	1	Insignificant	Not required
Re25	Without BRT	64.6	65.7	5	1	Insignificant	Not required
Re26	Without BRT	66.4	67.5	5	1	Insignificant	Not required

Impact Assessment Ra 0 to < 3 dB change : Insignificant
=>3 to < 5 dB change : Noticeable
=> 5 to < 10 dB change: Significant
=> 10 dB change : Very Significant

TABLE 4.2
ENVIRONMENTAL NOISE IMPACT ASSESSMENT
BRT EAST
WITH BUSWAY
CITY OF MISSISSAUGA

Receptor Code	Receptor Name	Existing Sound Levels dBA	Future Sound Levels dBA	Excess Criteria for mitigation dBA	Future Sound Levels Minus Existing Sound Levels	Significance of the Change due to the Future Sound Levels Minus Existing Sound Levels	Noise Control measures As per Protocol
Re1	With BRT	62.3	63.9	5	2	Insignificant	Not required
Re2	With BRT	63.2	65.2	5	2	Insignificant	Not required
Re3	With BRT	63.0	64.2	5	1	Insignificant	Not required
Re4	With BRT	63.6	65.2	5	2	Insignificant	Not required
Re5	With BRT	62.8	64.4	5	2	Insignificant	Not required
Re6	With BRT	59.2	60.4	5	1	Insignificant	Not required
Re7	With BRT	50.0	52.0	5	2	Insignificant	Not required
Re8	With BRT	55.7	52.2	5	-3	Noticeable	Not required
Re9	With BRT	53.9	56.7	5	3	Insignificant	Not required
Re10	With BRT	54.4	56.5	5	2	Insignificant	Not required
Re11	With BRT	54.2	58.7	5	5	Noticeable	Not required
Re12	With BRT	54.5	56.0	5	2	Insignificant	Not required
Re13	With BRT	52.5	54.2	5	2	Insignificant	Not required
Re14	With BRT	53.6	56.2	5	3	Insignificant	Not required
Re15	With BRT	52.9	54.1	5	1	Insignificant	Not required
Re16	With BRT	53.3	54.4	5	1	Insignificant	Not required
Re17	With BRT	61.6	63.4	5	2	Insignificant	Not required
Re18	With BRT	64.1	65.9	5	2	Insignificant	Not required
Re19	With BRT	64.5	66.4	5	2	Insignificant	Not required
Re20	With BRT	65.2	67.2	5	2	Insignificant	Not required
Re21	With BRT	64.6	65.4	5	1	Insignificant	Not required
Re22	With BRT	72.1	75.0	5	3	Insignificant	Not required
Re23	With BRT	63.9	68.7	5	5	Noticeable	Not required
Re24	With BRT	64.2	70.8	5	7	Significant	To Be Investigated
Re25	With BRT	64.6	70.9	5	6	Significant	To Be Investigated
Re26	With BRT	66.4	67.8	5	1	Insignificant	Not required

ıpact Assessment Rating :

0 to < 3 dB change : Insignificant
=>3 to < 5 dB change : Noticeable
=> 5 to < 10 dB change: Significant
=> 10 dB change : Very Significant

TABLE 4.3
ENVIRONMENTAL NOISE ASSESSMENT
PROPOSED MISSISSAUGA BRT EAST STATIONS

Receptor	Time	Maximum Bus Station Sound Level Leq (1h)	Minimum Ambient Noise Level Leq (1h)	MOE Exclusion Limit Leq (1h)	Applicable Criteria Leq (1h)	Excess of Bus Station Sound Level Above Applicable Criteria
Central Parkway East Bus Station						
Re19	Day	51 dBA	65 dBA	50 dBA	65 dBA	n/a
	Evening	48 dBA	64 dBA	47 dBA	64 dBA	n/a
	Night	44 dBA	64 dBA	45 dBA	64 dBA	n/a
Cawthra Road Bus Station						
Re16	Day	<40 dBA	59 dBA	50 dBA	59 dBA	n/a
	Evening	<40 dBA	58 dBA	47 dBA	58 dBA	n/a
	Night	<40 dBA	57 dBA	45 dBA	57 dBA	n/a
Tomken Road Bus Station						
Re14	Day	52 dBA	53 dBA	50 dBA	53 dBA	n/a
	Evening	49 dBA	54 dBA	47 dBA	54 dBA	n/a
	Night	44 dBA	49 dBA	45 dBA	49 dBA	n/a

TABLE 4.3 Cont'd
ENVIRONMENTAL NOISE ASSESSMENT
PROPOSED MISSISSAUGA BRT EAST STATIONS

Receptor	Time	Maximum Bus Station Sound Level Leq (1h)	Minimum Ambient Noise Level Leq (1h)	MOE Exclusion Limit Leq (1h)	Applicable Criteria Leq (1h)	Excess of Bus Station Sound Level Above Applicable Criteria
Dixie Road Bus Station						
Re12	Day	53 dBA	60 dBA	50 dBA	60 dBA	n/a
	Evening	51 dBA	60 dBA	47 dBA	60 dBA	n/a
	Night	46 dBA	57 dBA	45 dBA	57 dBA	n/a
Renforth Drive Bus Station						
Re7	Day	46 dBA	49 dBA	50 dBA	49 dBA	n/a
	Evening	46 dBA	48 dBA	47 dBA	48 dBA	n/a
	Night	45 dBA	46 dBA	45 dBA	46 dBA	n/a

TABLE 5.1
COMPARISON OF MEASURED VERSUS PREDICTED DAY AND NIGHT AMBIENT SOUND LEVELS

Location	Time	Measured Ambient Level	Predicted Ambient Level	Difference (Measured - Predicted Ambient)
Re6	Day, Leq(16h)	61 to 62 dBA	58 dBA	3 to 4 dBA
	Night, Leq(8h)	59 to 60 dBA	51 dBA	8 to 9 dBA
Re11	Day, Leq(16h)	56 to 57 dBA	58 dBA	-1 to -2 dBA
	Night, Leq(8h)	54 to 55 dBA	51 dBA	3 to 4 dBA
Re16	Day, Leq(16h)	49 to 54 dBA	53 dBA	-4 to 1 dBA
	Night, Leq(8h)	51 to 52 dBA	47 dBA	4 to 5 dBA

TABLE 5.2
COMPARISION OF MEASURED VERSUS PREDICTED HOURLY AMBIENT SOUND LEVELS

Location	Time	Measured Ambient Level, Leq(1h)	Predicted Ambient Level, Leq(1h)	Difference (Measured - Predicted Ambient)
Re6	Day	61 dBA	58 dBA	3 dBA
	Evening	60 dBA	58 dBA	2 dBA
	Night	63 dBA	56 dBA	7 dBA
Re11	Day	56 dBA	59 dBA	-3 dBA
	Evening	54 dBA	58 dBA	-4 dBA
	Night	57 dBA	56 dBA	1 dBA
Re16	Day	45 dBA	54 dBA	-9 dBA
	Evening	48 dBA	53 dBA	-5 dBA
	Night	54 dBA	52 dBA	2 dBA

Notes

(1) MOE time periods:
- Day: 7am -7pm
- Evening 7pm-11pm
- Night:11pm-7am

(2) Time periods used in this study to coincide with BRT station peak hours:
- Day: 7am-10am
- Evening: 7pm-8pm
- Night: 6am-7am

FIGURES

FIGURE 1
KEY PLAN

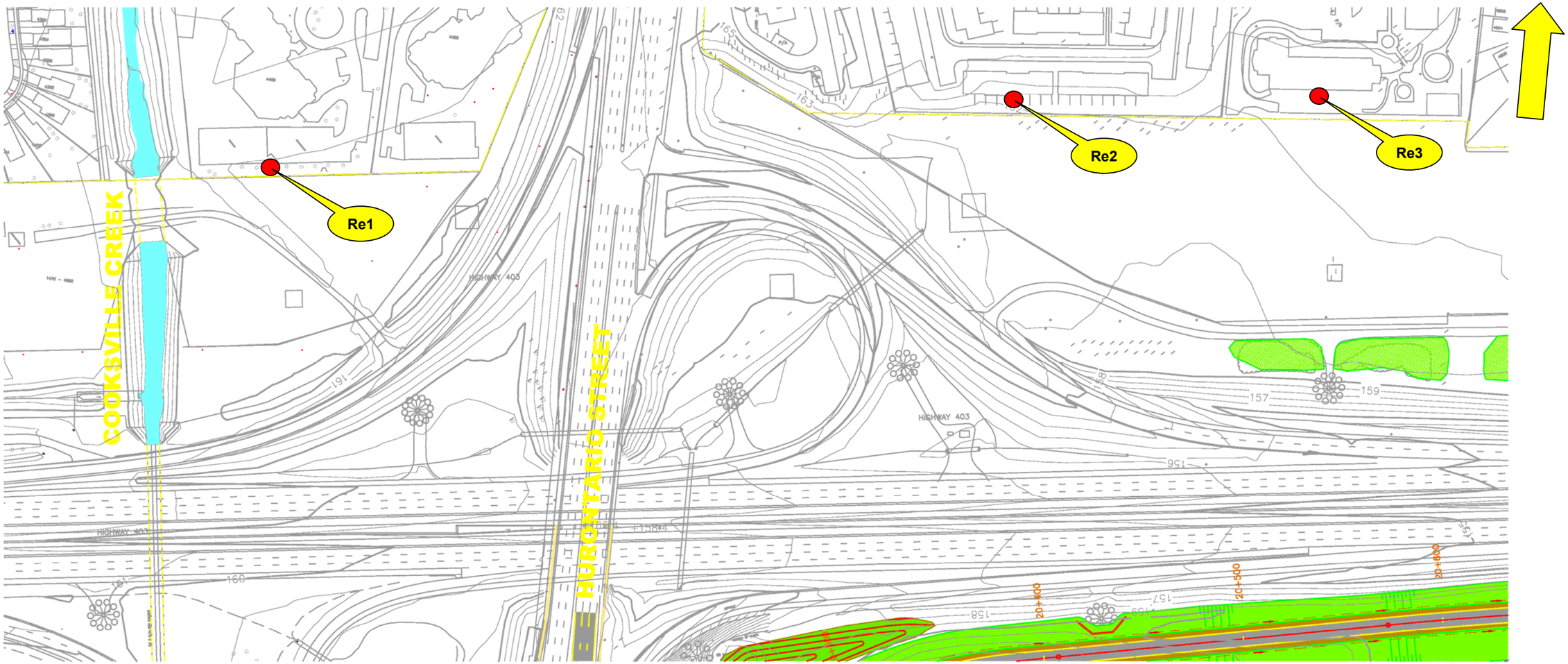


FIGURE 2.1
POINTS OF RECEPTION

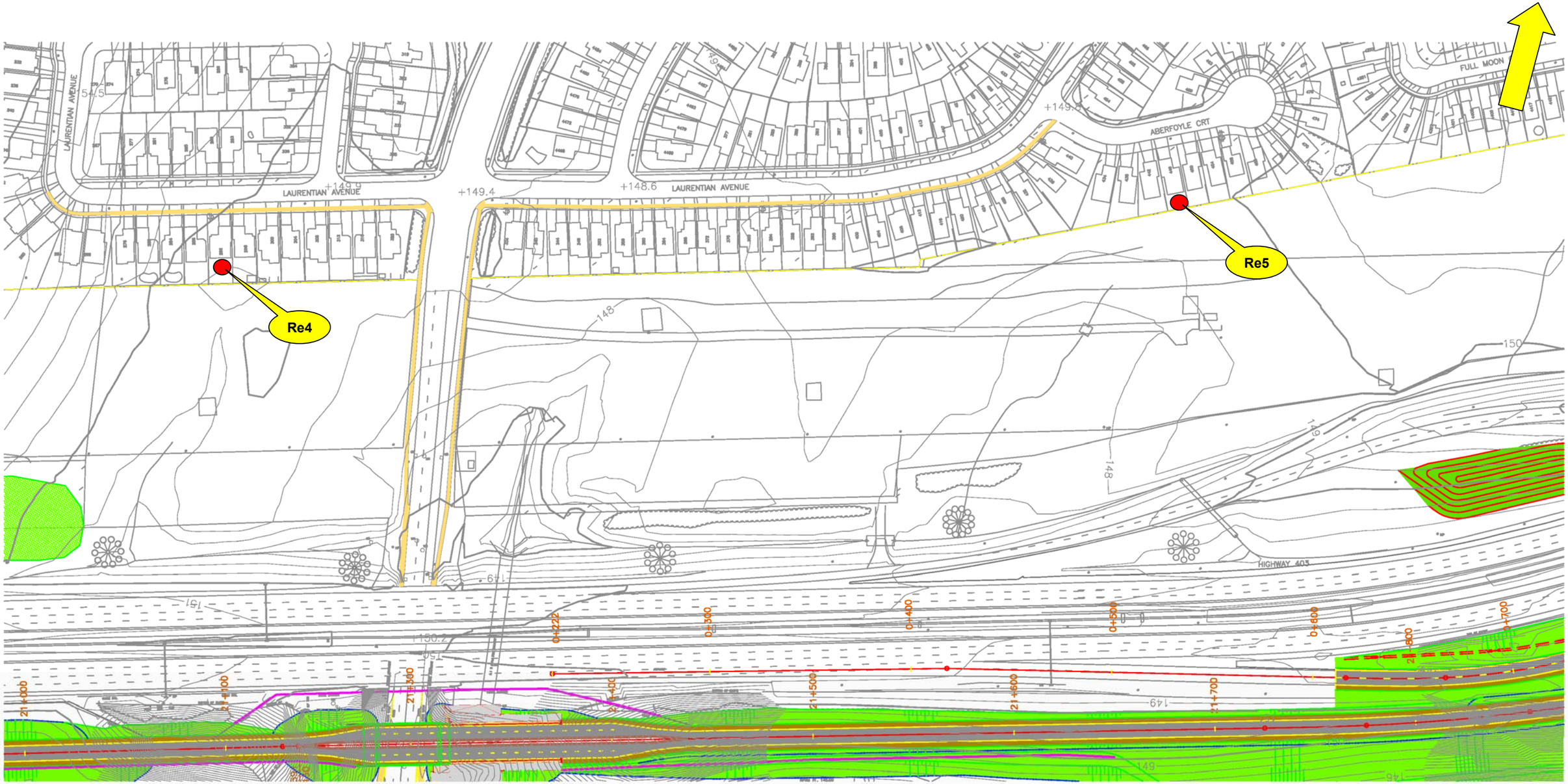


FIGURE 2.2
POINTS OF RECEPTION

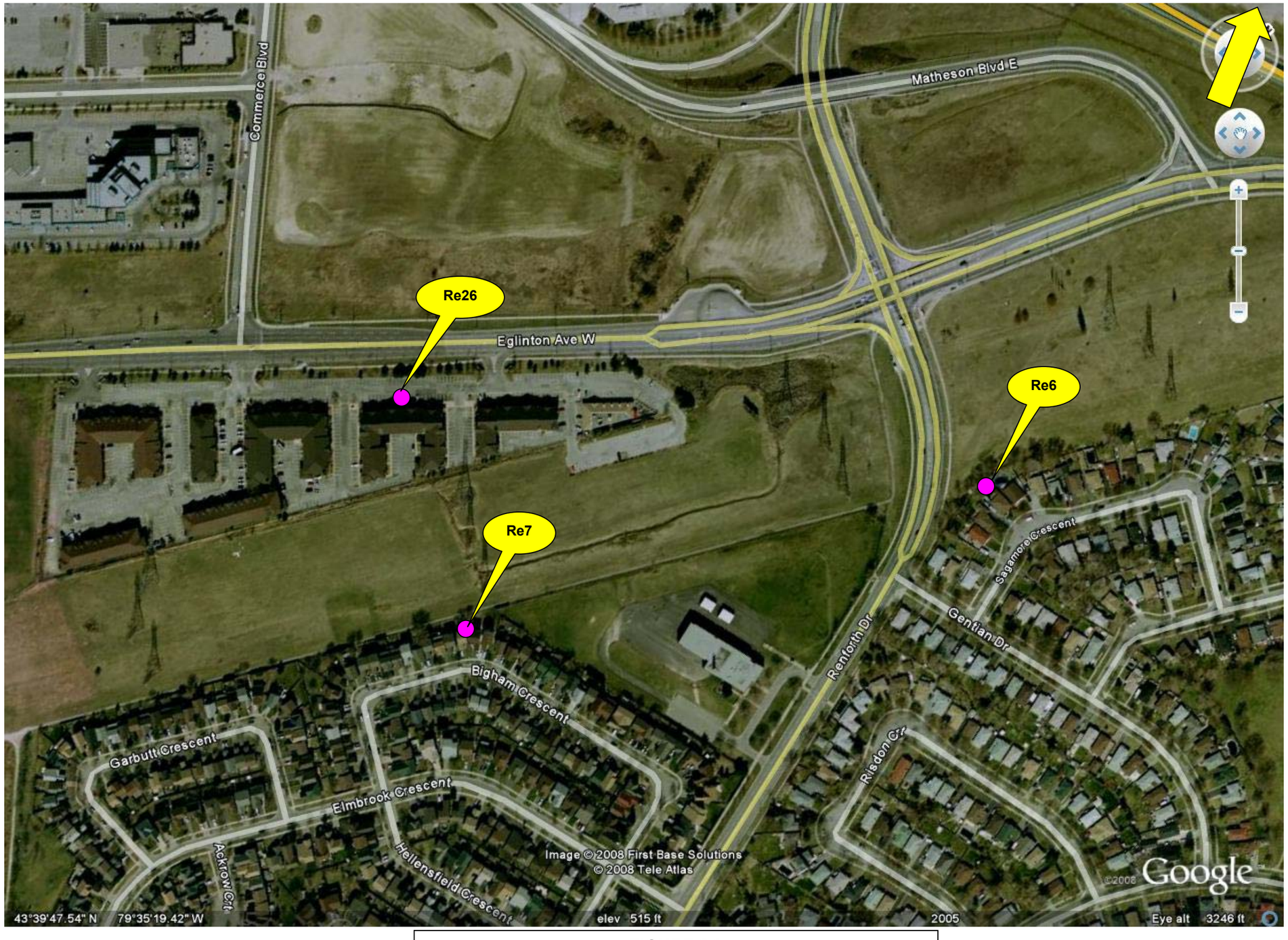


FIGURE 2.3
POINTS OF RECEPTION

FIGURE 2.4
POINTS OF RECEPTION

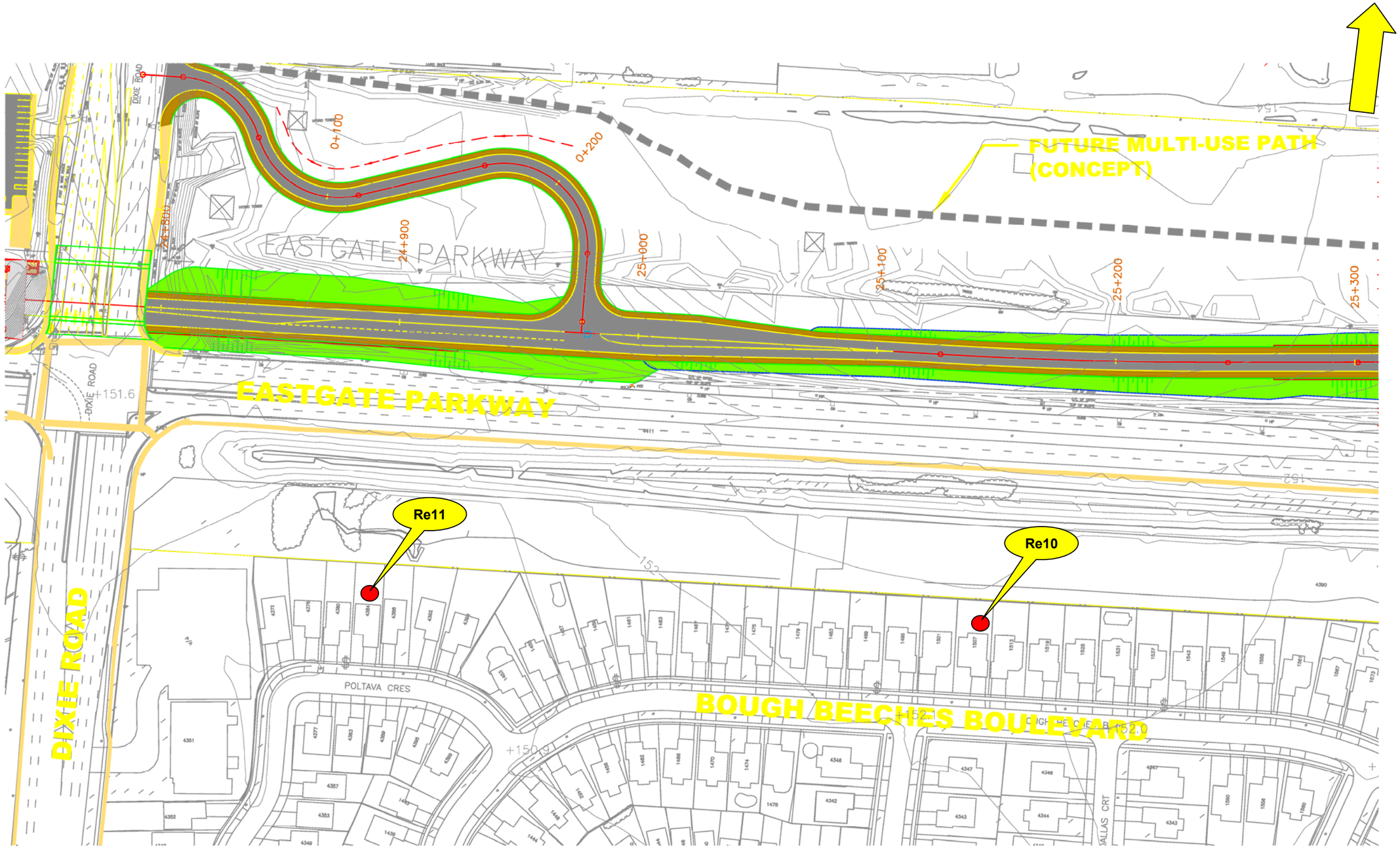


FIGURE 2.5
POINTS OF RECEPTION

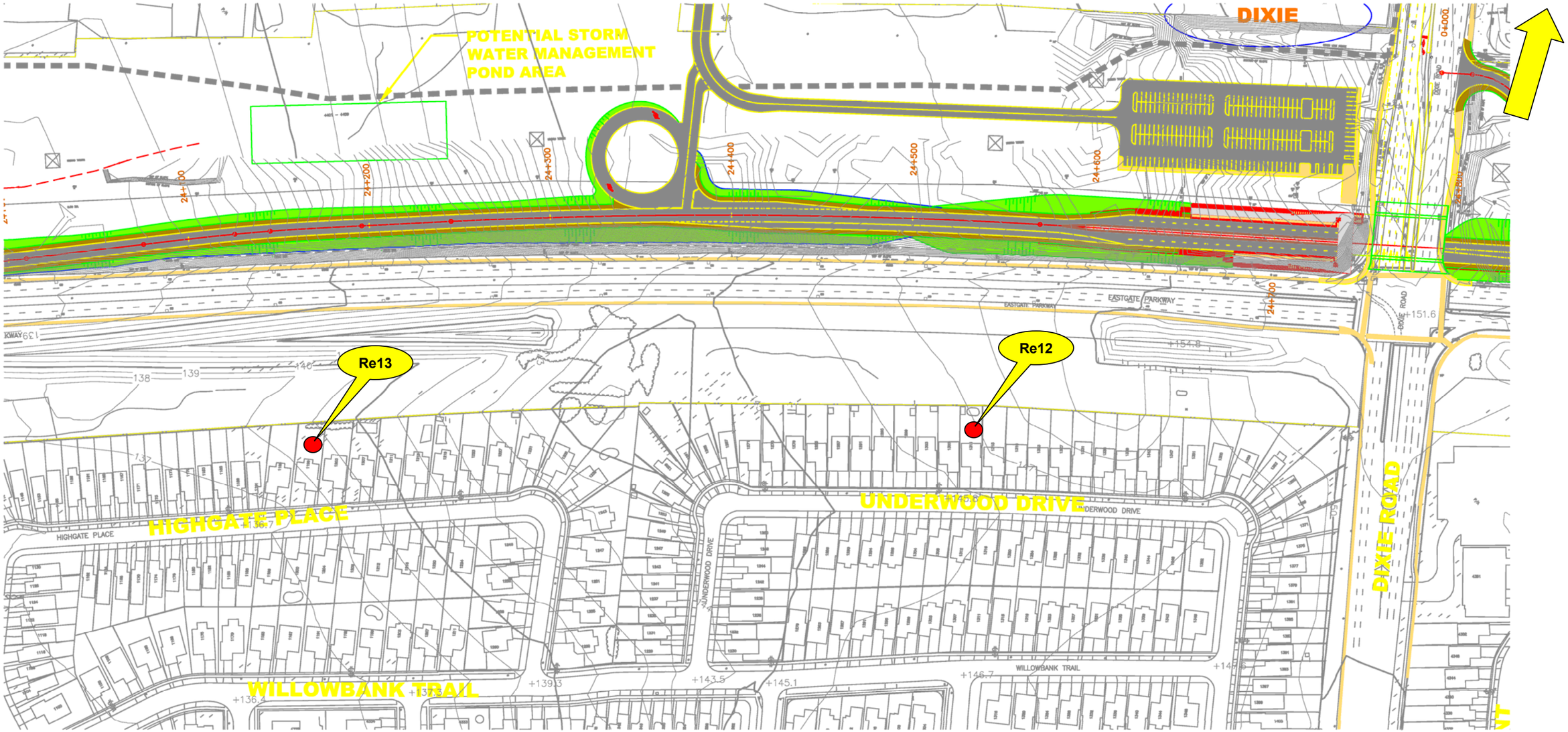


FIGURE 2.6
POINTS OF RECEPTION

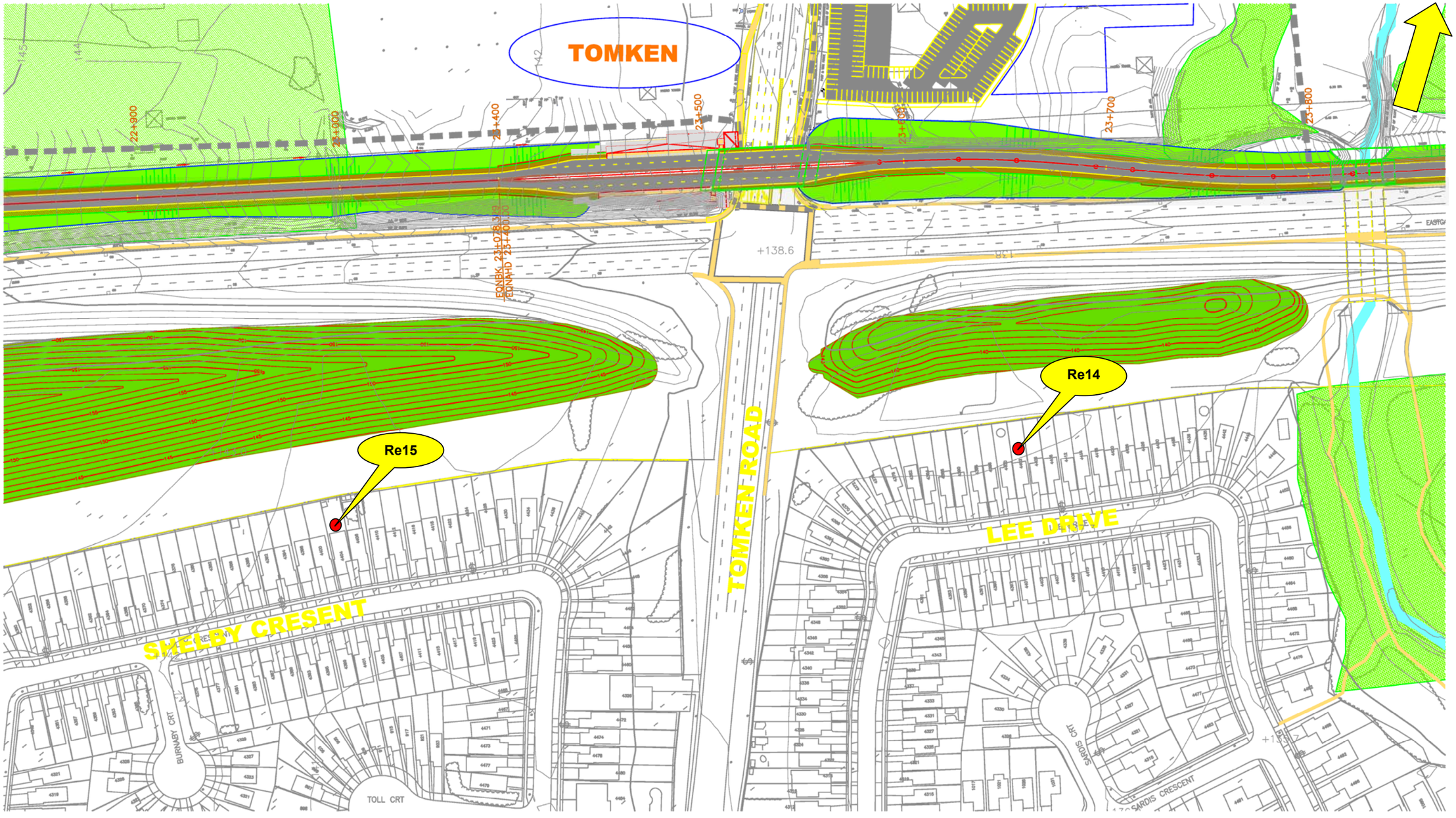


FIGURE 2.7
POINTS OF RECEPTION

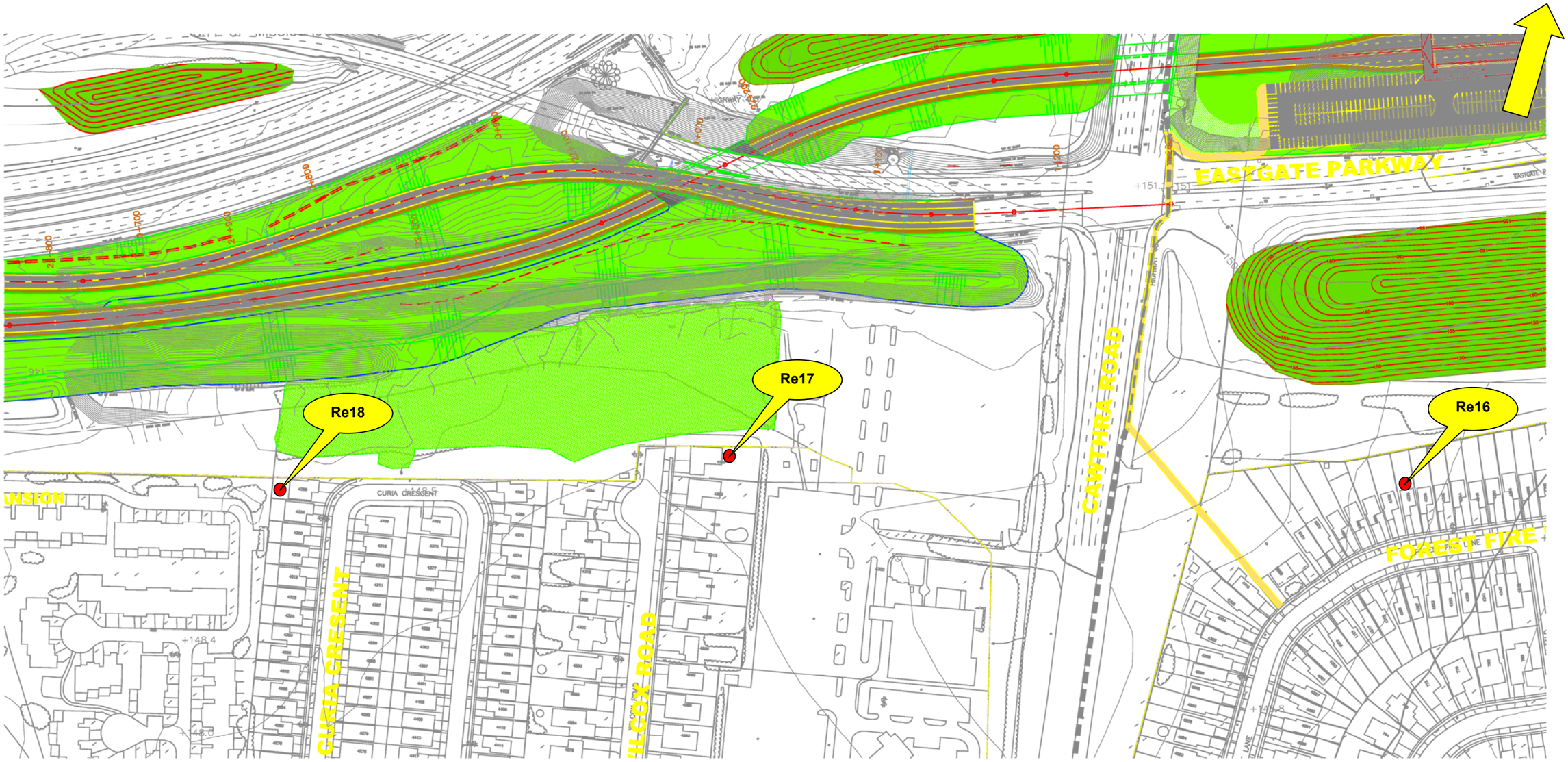


FIGURE 2.8
POINTS OF RECEPTION

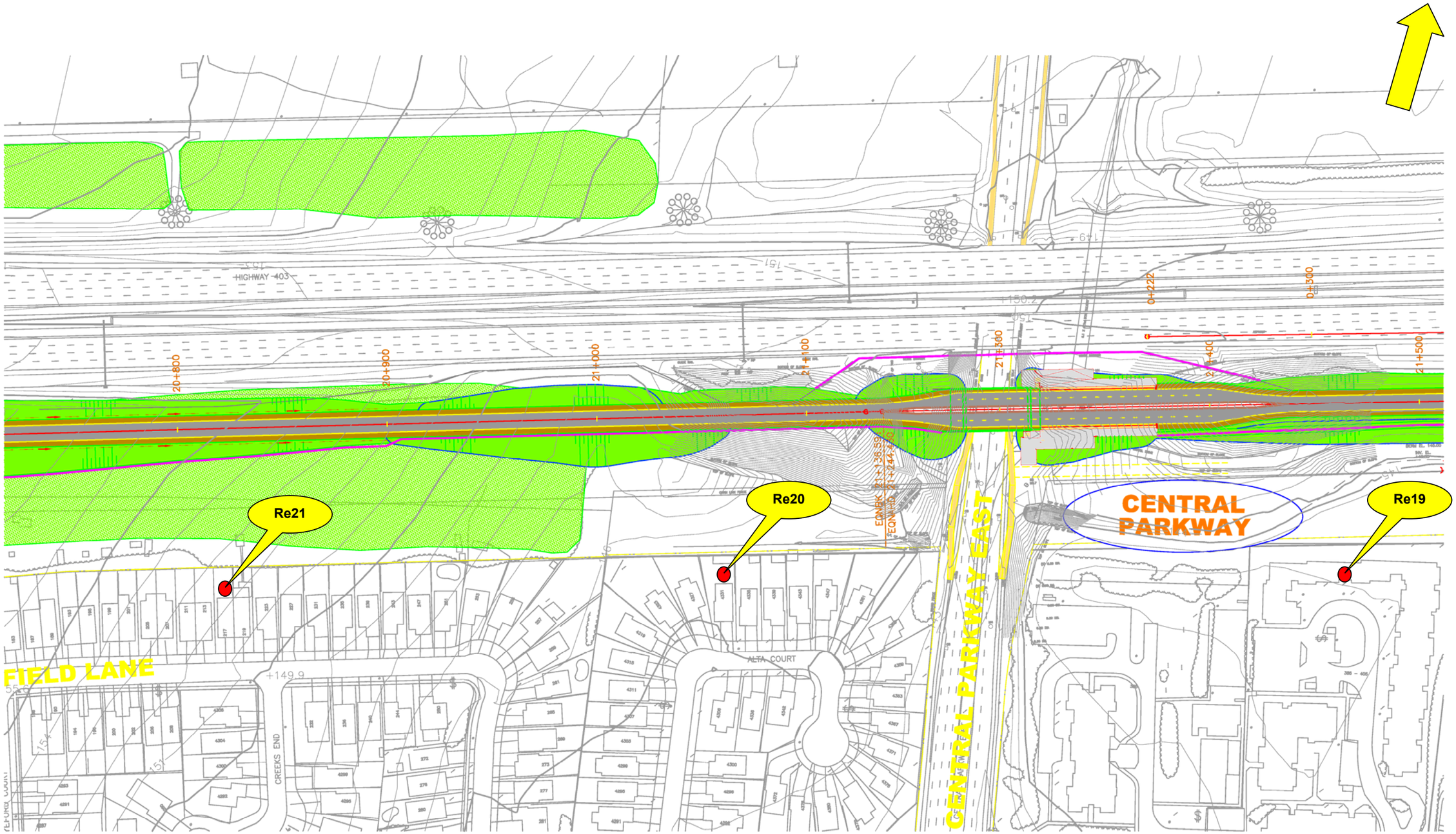


FIGURE 2.9
POINTS OF RECEPTION

FIGURE 2.10
POINTS OF RECEPTION

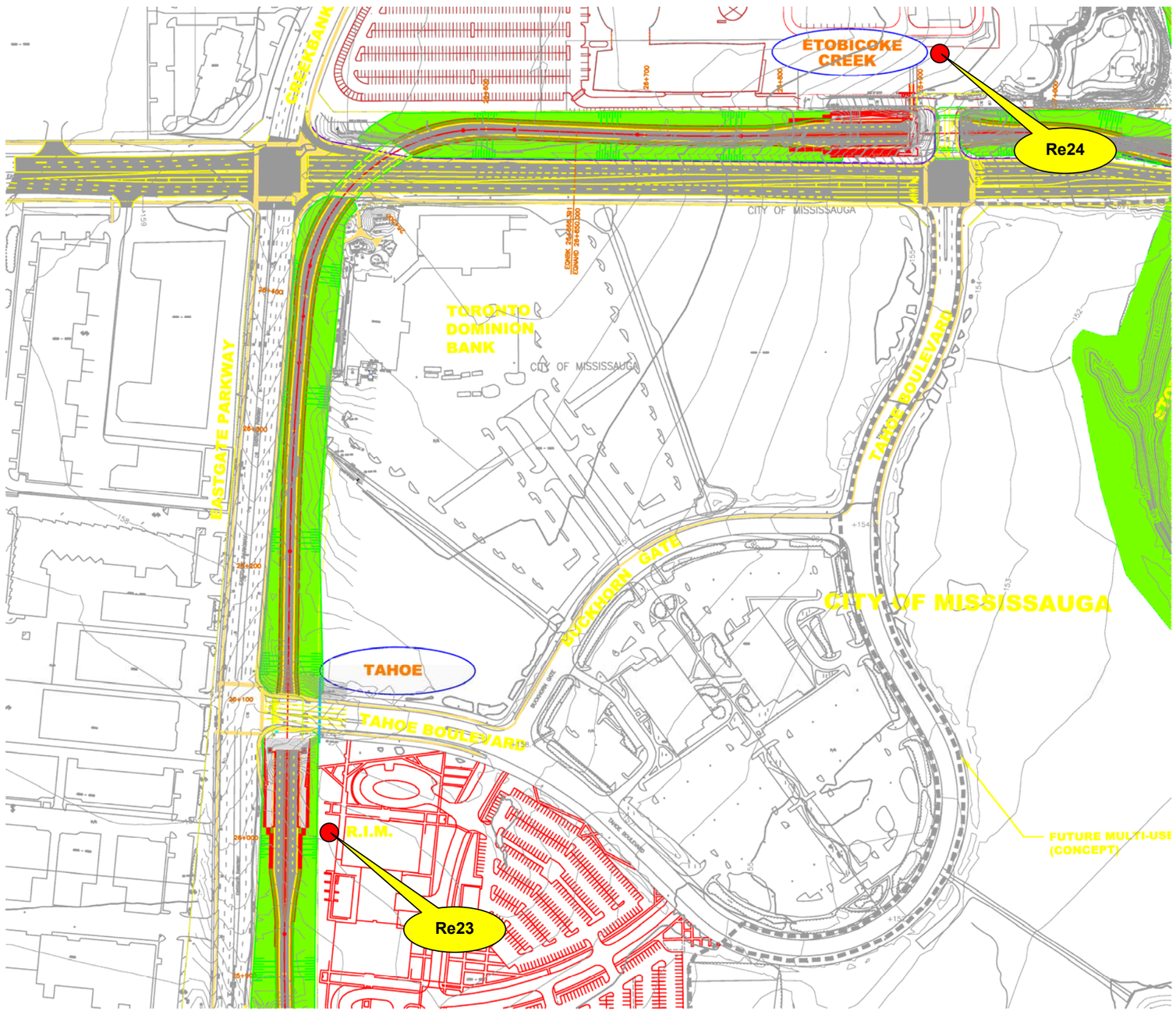


FIGURE 2.11
POINTS OF RECEPTION

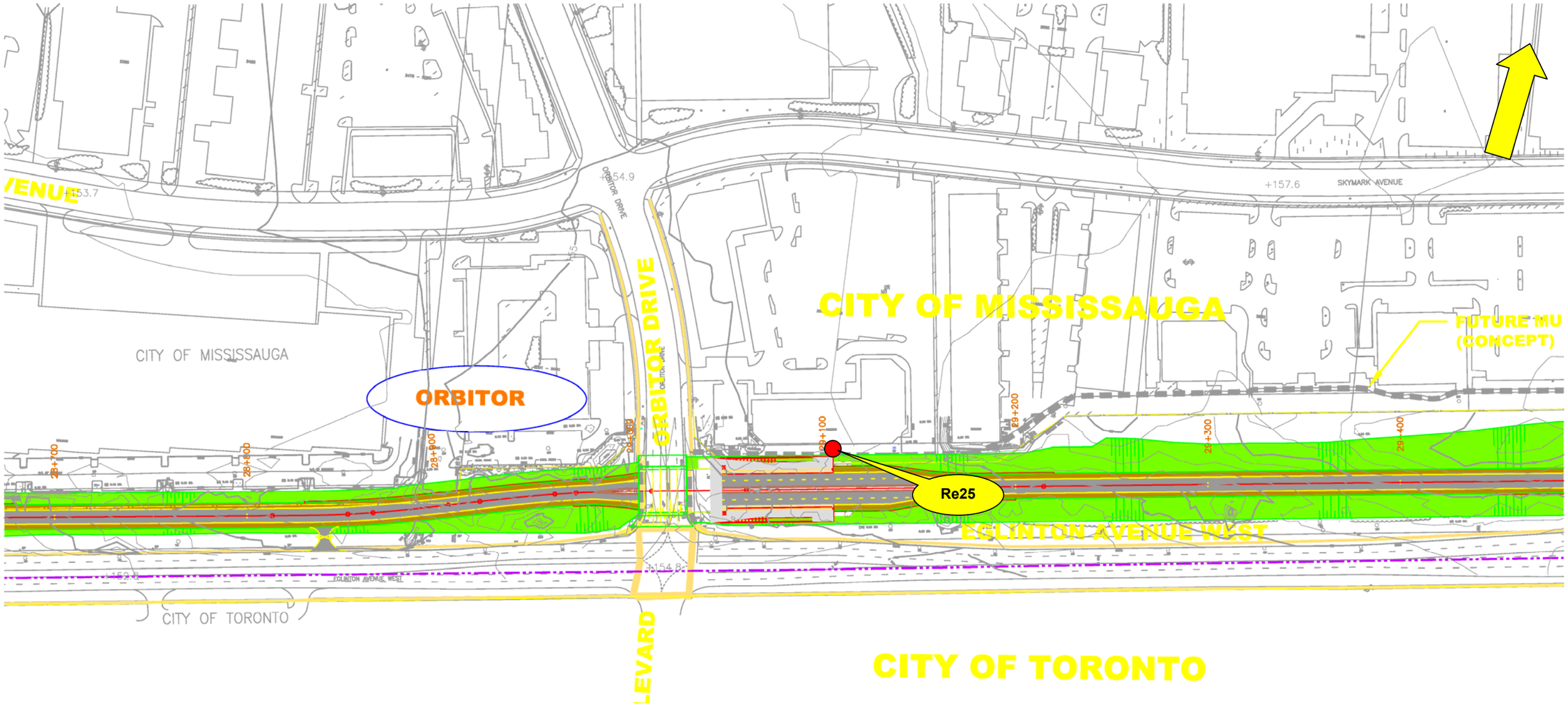
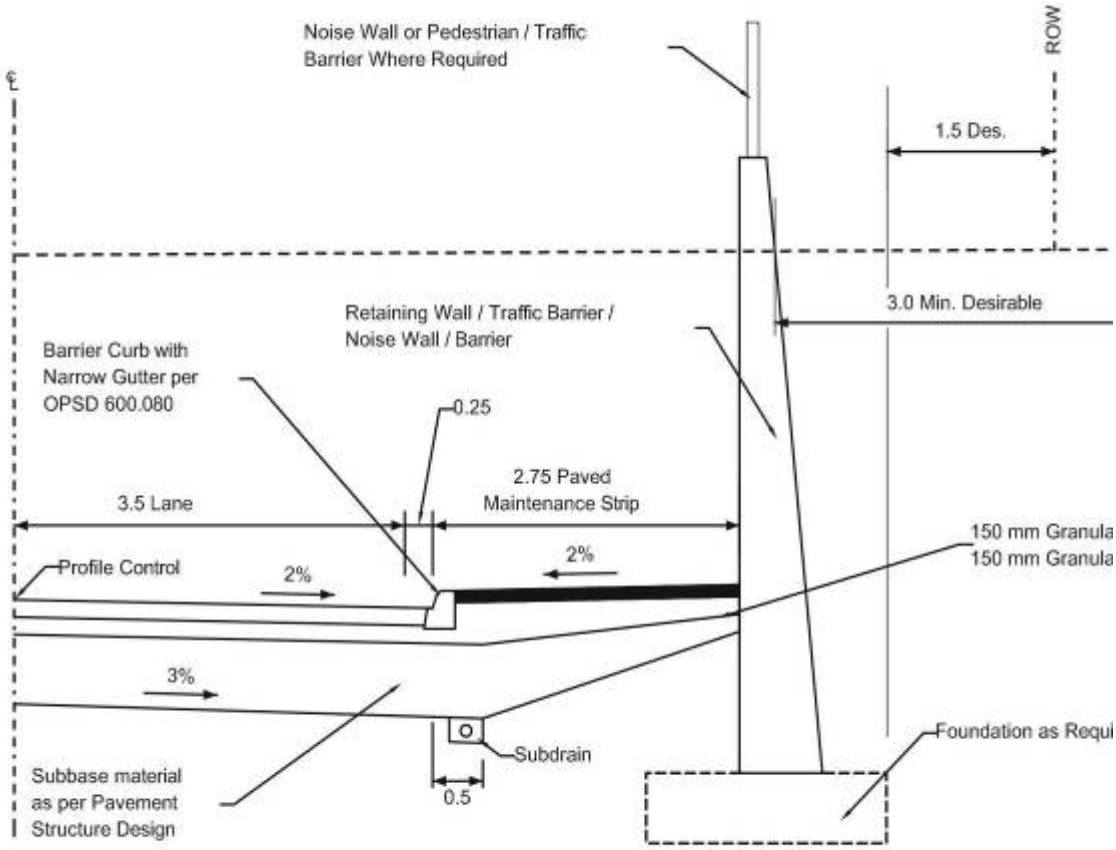


FIGURE 2.12
POINTS OF RECEPTION



Cut Section Where Right-of-Way is Restricted

FIGURE 3.1
BUSWAY RETAINED CUT

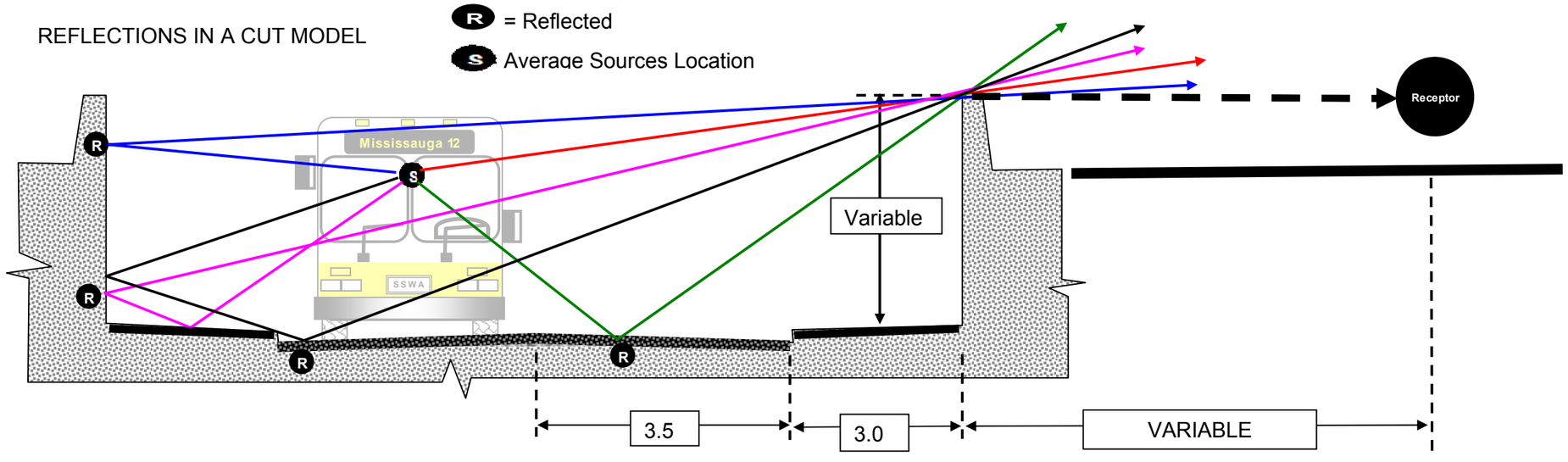


FIGURE 3.2
SOUND REFLECTIONS IN A RETAINED CUT

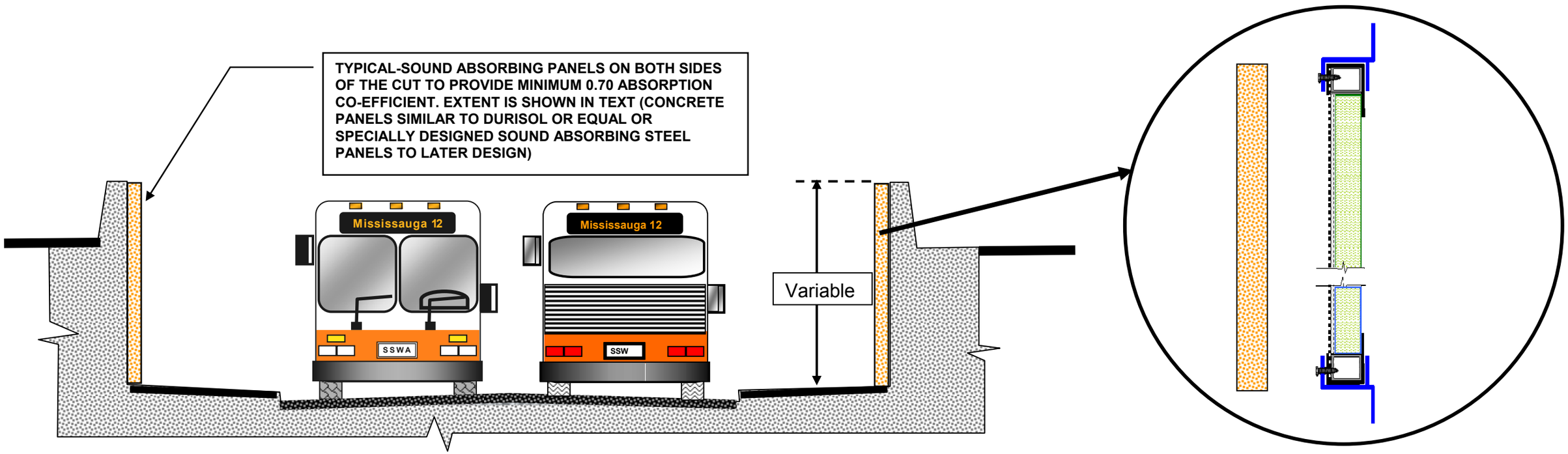


FIGURE 4.1
SOUND ABSORBING PANELS

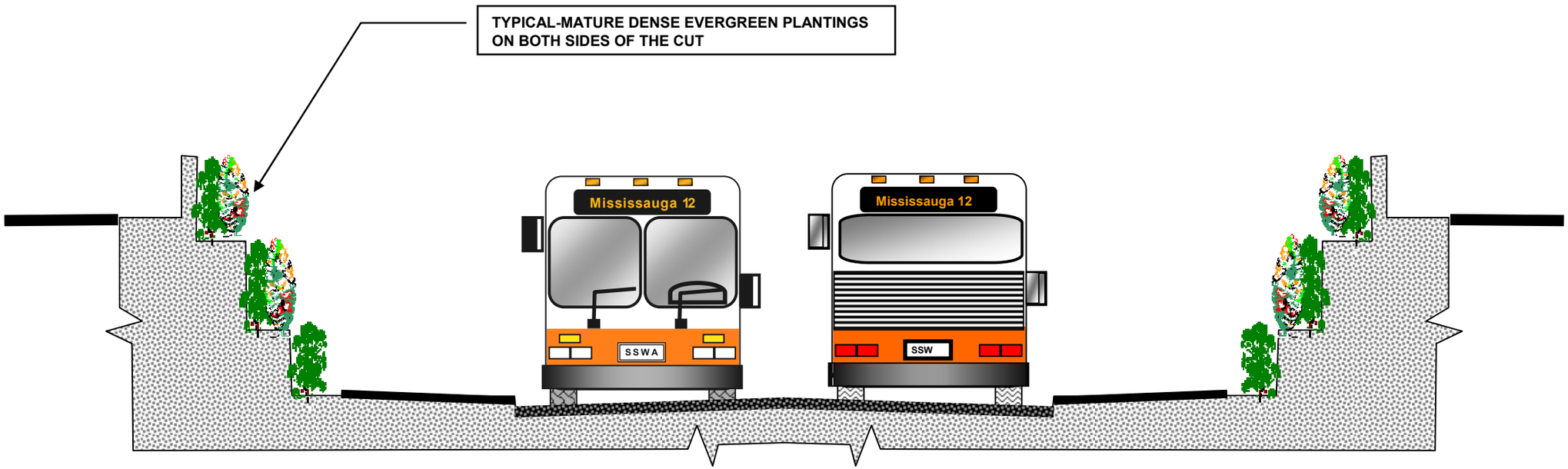


FIGURE 4.2
SOUND ABSORBING PLANTINGS

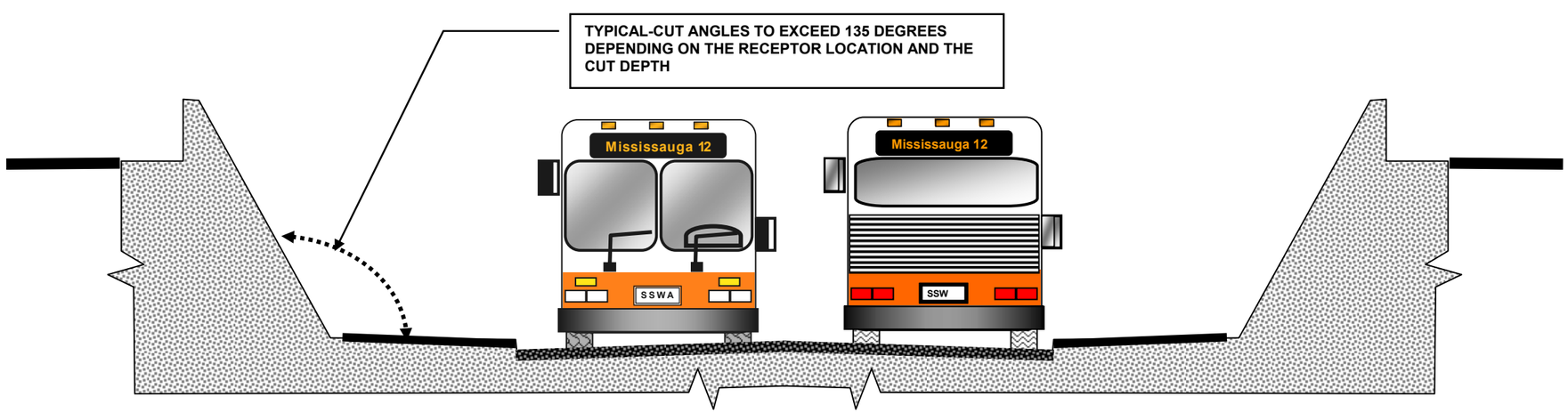


FIGURE 4.3
ADJUSTING THE SLOPE OF THE CUT SIDES

PHOTOGRAPHS

Photo 1: Tucana Court Apartment Building – View 1 South

Photo 2: Tucana Court Apartment Building – View 2 South

Photo 3: Acorn Place Townhouses – View 1 South

Photo 4: Acorn Place Townhouses – View 2 South

Photo 5: Acorn Place Apartment Building – View 1 South

Photo 6: Acorn Place Apartment Building – View 2 South

Photo 7: Acorn Place Townhouse – View from Highway 403

Photo 8: Acorn Place Apartment Building – View from Highway 403

Photo 9: Sagamore Crescent Residences – View 1

Photo 10: Sagamore Crescent Residences – View 2

Photo 11: Audubon Boulevard Residences – View 1

Photo 12: Audubon Boulevard Residences – View 2

Photo 13: Copseholm Terrace Residences – View 1

Photo 14: Copseholm Terrace Residences – View 2

Photo 15: Berm south of Eastgate Pkwy & east of Dixie Road – View 1

Photo 16: Berm south of Eastgate Pkwy & east of Dixie Road – View 2

Photo 17: MTO Noise Wall at south-east corner of Highway 403 & Central Pkwy E – View 1

Photo 18: MTO Noise Wall at south-east corner of Highway 403 & Central Pkwy E – View 2

Photo 19: MTO Noise Wall/Berm at south-east corner of Highway 403 & Central Pkwy E – View 3

Photo 20: MTO Noise Berm at south-east corner of Highway 403 & Central Pkwy E – View 4

Photo 21: MTO Noise Wall at south-west corner of Highway 403 & Central Pkwy E – View 1

Photo 22: MTO Noise Berm at south-west corner of Highway 403 & Central Pkwy E – View 2

Photo 23: MTO Noise Berm at south-west corner of Highway 403 & Central Pkwy E – View 3

Photo 24: MTO Noise Berm at south-west corner of Highway 403 & Central Pkwy E – View 4

APPENDIX A

TRAFFIC VOLUMES

The technical appendices for the noise analyses
are available on request from the Mississauga BRT Project Office