DURHAM – SCARBOROUGH
Bus Rapid Transit

Appendix L1 –
Pavement Condition Survey and Design

Prepared for Metrolinx
by IBI Group & Parsons

TECHNICAL MEMORANDUM

DATE December 24, 2021 **Project No.** 21473923

TO Margaret Parkhill, P.Eng.
Parsons

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PAVEMENT CONDITION SURVEY AND PAVEMENT DESIGN RECOMMENDATIONS
DURHAM-SCARBOROUGH BUS RAPID TRANSIT (DS BRT)
SCARBOROUGH AND DURHAM, ONTARIO

1.0 INTRODUCTION

Golder Associates Ltd. (Golder) was retained by IBI Group to carry out a desktop study and Pavement Condition Assessment (PCA) along Ellesmere Road from McCowan Road to Highway 2, and along Highway 2 from Ellesmere Road to Simcoe Street South in Toronto and the Regional Municipality of Durham (Durham), Ontario. IBI is carrying out the overall preliminary design for the "Metrolinx Durham-Scarborough Bus Rapid Transit (DS BRT) Project". This technical memorandum (memo) presents the results of the desktop review and PCA, and provides preliminary pavement rehabilitation and widening designs to assist Parsons in the overall costing of the DS BRT.

Metrolinx completed the DS BRT initial business case in 2018, which recommended a preferred BRT alignment along the project limits referenced above. The DS BRT is recognized as a crucial transportation corridor connecting people through the Regions of Scarborough and Durham. With rapid growth and the demand for travel along this corridor, the DS BRT is needed to link communities in Toronto and Durham.

2.0 DESKTOP STUDY

Golder completed a desktop study of historical documents available at the time of preparing this memo. The documents provided by IBI included relevant geotechnical/pavement engineering information along some sections of the proposed corridor of the DS BRT. Golder specifically reviewed the following documents listed in Table 1:

Table 1: Summary of Historical Documents

Report	Title	Dated
1	Geotechnical Investigation, Watermain Replacement, Kingston Road BRT – Dixie Road to Liverpool Road (D2021-001)	May 6, 2020
2	Geotechnical Investigation, Pine Creek Culver Extension, Kingston Road BRT – Dixie Road to Liverpool Road (D2021-001)	November 20, 2018
3	Geotchnical Investigation, Highway 2 Bus Rapid Transit Proposed Retaining Walls Between About Sta. 19+850 and Sta. 20+350	November 16, 2017

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Report	Title	Dated
4	Pavement Design Report, Preliminary/Detail Design – Highway 2 Bus Rapid Transit (BRT) Quick Win Project	June 20, 2013
5	Pavement/Geotechnical Investigation for the Kingston Road Bus Rapid Transit, Kingston Road from Dixie Road to Liverpool Road (D2021-001)	March 19, 2020

2.1 Existing Pavement Structures and Subgrade Soils

Table 2 presents a summary of the existing pavement structures and subgrade soils, as described in the historical documents.

Table 2: Summary of Existing Pavement Structures and Subgrade Soils

Report	Location	Pavement Structure	Subgrade Soil(s)
1	Hwy 2 (Kingston Road) from Dixie Rd to Liverpool Rd (Pickering, ON)	150 – 200 mm – HMA 490 – 1220 mm – Granular Base and Subbase	Silty Clay
2	Hwy 2 from Dixie Rd to Liverpool Rd (Pickering, ON)		
3	Hwy 2 at Ritchie Ave (Ajax, ON)	150 – 200 mm – HMA 460 – 1220 mm – Granular Base and Subbase	Silty Clay Silty Clay – Clayey Silt Silt and Sand Silty Sand Sand Sandy Silt
4	Hwy 2 from Steeple Hill Blvd to Wicks Dr (Pickering & Ajax, ON)	70 – 290 mm – HMA 100 – 540 – Granular Base 150 – 1160 – Granular Subbase	Clayey Silt Silty Sand Silty Clay Sandy Silt
5	Hwy 2 from Dixie Rd to Liverpool Rd (Pickering, ON)	110 – 170 – HMA 180 – 340 – Granular Base 750 – 1100 – Granular Subbase	Silty Clay Silty Sand

3.0 PAVEMENT CONDITION ASSESSMENT

The PCA was carried out on August 24, 2021 to evaluate the condition of the existing pavements. The purpose of the visual assessment was to document the existing pavement surface distresses and the surface drainage characteristics. The PCA was carried out in accordance with the Ministry's *"Manual for Condition Rating for Flexible Pavements, SP-024*".

Based on the results of the PCA, the proposed alignment of the DS BRT was split into 20 different sections. Table 3 describes the pavement condition along each section at the time of the survey (August 24, 2021).

Table 3: Pavement Condition Survey Results

Section	Distresses
Section 1 **Ellesmere Rd** **From McCowan Rd to Markham Rd** **~1.7 km (Scarborough)** This section consists of an urban cross section with four lanes (two per direction), an intermittent shared left turn lane, and regular bus inlets.	■ PCR = 85 and RCR = 8.5 ■ Intermittent – slight flushing ■ Intermittent – slight longitudinal cracking ■ Intermittent – slight transverse cracking
Section 2 **Ellesmere Rd** **From Markham Rd to Military Trail** **~1.2 km (Scarborough)** This section consists of an urban cross section with four lanes (two per direction), occasional left turn lanes, and regular bus inlets.	■ PCR = 65 and RCR = 6.5 ■ Frequent – moderate ravelling ■ Intermittent – slight flushing ■ Intermittent – moderate potholes ■ Intermittent – severe pavement edge breaks ■ Extensive – slight wheel track rutting ■ Intermittent – moderate utility trench deformation ■ Frequent – severe longitudinal cracking ■ Frequent – moderate to severe transverse cracking ■ Intermittent – severe pavement edge cracking ■ Intermittent – moderate alligator cracking ■ Manual patching <20% ■ Crack rout and seal <20%

Section	Distresses
Section 3 **Ellesmere Rd** **From Military Trail to Morningside Ave** **~2.0 km (Scarborough)** This section consists of an urban cross section with four lanes (two per direction), occasional left turn lanes, and regular bus inlets.	■ PCR = 85 and RCR = 8.5 ■ Intermittent – slight flushing ■ Intermittent – slight longitudinal cracking ■ Intermittent – slight transverse cracking ■ Machine patching <20%
Section 4 **Ellesmere Rd** **From Morningside Ave to Kingston Rd (Extending along Kingston Rd to Hwy 401)** **~3.5 km (Scarborough)** This section consists of an urban cross section with four lanes (two per direction), occasional left turn lanes, and regular bus inlets. Ellesmere Road reduces from four to two lanes east of Meadowvale Road.	■ PCR = 60 and RCR = 6.0 ■ Frequent – moderate ravelling ■ Intermittent – slight flushing ■ Intermittent – moderate potholes ■ Intermittent – moderate pavement edge breaks ■ Frequent – moderate wheel track rutting ■ Intermittent – moderate utility trench deformation ■ Extensive – moderate to severe longitudinal cracking ■ Frequent – moderate to severe transverse cracking ■ Intermittent – severe pavement edge cracking ■ Frequent – moderate map cracking ■ Frequent – moderate to severe alligator cracking ■ Manual patching <20% ■ Machine patching between 20% to 50% ■ Crack rout and seal <20%
Section 5 **Kingston Rd (Hwy 2)** **From Hwy 401 to the CN Rail** **~5.3 km (Scarborough / Pickering)** This section consists of an urban cross section with four lanes (two per direction), and occasional left turn lanes.	■ PCR = 80 and RCR = 8.0 ■ Intermittent – slight ravelling ■ Intermittent – slight flushing ■ Intermittent – severe potholes ■ Intermittent – slight wheel track rutting ■ Intermittent – slight utility trench deformation ■ Intermittent – slight longitudinal cracking ■ Intermittent – slight transverse cracking ■ Intermittent – moderate pavement edge cracking ■ Intermittent – slight map cracking ■ Manual patching <20% ■ Machine patching <20% ■ Crack rout and seal <20%

Section	Distresses
Section 6 **Kingston Rd (Hwy 2)** **From the CN Rail to Liverpool Rd** **~1.0 km (Pickering)** This section consists of an urban cross section with four lanes (two per direction), and an intermittent shared left turn lane. There is a small rural section east of Walnut Lane.	■ PCR = 75 and RCR = 7.5 ■ Frequent – slight ravelling ■ Extensive – slight flushing ■ Intermittent – severe potholes ■ Intermittent – moderate pavement edge breaks ■ Frequent – slight wheel track rutting ■ Frequent – slight to moderate longitudinal cracking ■ Frequent – slight transverse cracking ■ Intermittent – slight pavement edge cracking ■ Intermittent – moderate map cracking ■ Intermittent – slight to moderate alligator cracking ■ Manual patching <20% ■ Machine patching <20% ■ Crack rout and seal between 20% and 50%
Section 7 **Kingston Rd (Hwy 2)** **From Liverpool Rd to Glengrove Rd South** **~1.0 km (Pickering)** This section consists of an urban cross section with six lanes (three per direction) including two designated bus lane (one per direction), two bicycle lanes (one per direction), and occasional left turn lanes.	■ PCR = 85 and RCR = 8.5 ■ Intermittent – slight ravelling ■ Intermittent – slight flushing ■ Intermittent – slight longitudinal cracking ■ Intermittent – slight transverse cracking
Section 8 **Kingston Rd (Hwy 2)** **From Glengrove Rd South to Royal Rd** **~1.0 km (Pickering)** This section consists of an urban cross section with four lanes (two per direction), and an intermittent shared left turn lane. There is a short rural section east of Valley Farm Road on the south side.	■ PCR = 75 and RCR = 7.5 ■ Intermittent – slight ravelling ■ Intermittent – slight flushing ■ Intermittent – moderate potholes ■ Intermittent – slight wheel track rutting ■ Intermittent – moderate utility trench distortion ■ Frequent – slight to moderate longitudinal cracking ■ Intermittent – slight transverse cracking ■ Intermittent – slight to moderate pavement edge cracking ■ Manual patching <20% ■ Machine patching <20% ■ Crack rout and seal <20%

Section	Distresses
Section 9 **Kingston Rd (Hwy 2)** **From Royal Rd to Southview Dr** **~1.0 km (Pickering)** This section consists of an urban cross section with six lanes (three per direction) including two designated bus lane (one per direction), two bicycle lanes (one per direction), and occasional left turn lanes.	■ PCR = 85 and RCR = 8.5 ■ Intermittent – slight ravelling ■ Intermittent – slight longitudinal cracking ■ Intermittent – slight transverse cracking
Section 10 **Kingston Rd (Hwy 2)** **From Southview Dr to Rotherglen Rd S** **~1.9 km (Pickering / Ajax)** This section consists of an urban cross section with four lanes (two per direction), and occasional left turn lanes.	■ PCR = 65 and RCR = 6.5 ■ Intermittent – slight to moderate ravelling ■ Frequent – slight flushing ■ Frequent – slight to moderate wheel track rutting ■ Intermittent – slight utility trench distortion ■ Frequent – slight to moderate longitudinal cracking ■ Intermittent – slight transverse cracking ■ Intermittent – moderate alligator cracking ■ Manual patching <20% ■ Machine patching <20% ■ Crack rout and seal >50%
Section 11 **Kingston Rd (Hwy 2)** **From Rotherglen Rd S to Salem Rd** **~2.6 km (Ajax)** This section consists of an urban cross section with six lanes (three per direction) including two designated bus lane (one per direction), two bicycle lanes (one per direction), and occasional left turn lanes.	■ PCR = 80 and RCR = 8.0 ■ Intermittent – slight flushing ■ Intermittent – slight wheel track rutting ■ Frequent – slight longitudinal cracking ■ Intermittent – slight transverse cracking ■ Intermittent – slight map cracking ■ Intermittent – slight alligator cracking ■ Manual patching <20% ■ Machine patching <20%

Section	Distresses
Section 12 **Kingston Rd (Hwy 2)** **From Salem Rd to Lakeridge Rd** **~2.5 km (Ajax)** This section consists of a rural cross section with four lanes (two per direction), and occasional left turn lanes.	■ PCR = 70 and RCR = 7.0 ■ Intermittent – slight ravelling ■ Intermittent – slight wheel track rutting ■ Extensive – slight to moderate longitudinal cracking ■ Extensive – slight transverse cracking ■ Intermittent – slight pavement edge cracking ■ Intermittent – slight map cracking ■ Intermittent – slight to moderate alligator cracking ■ Manual patching <20% ■ Machine patching <20% ■ Crack rout and seal >50%
Section 13 **Dundas St E (Hwy 2)** **From Lakeridge Rd to Fothergill Ct** **~1.6 km (Whitby)** This section consists of an urban cross section with four lanes (two per direction), and occasional left turn lanes.	■ PCR = 85 and RCR = 8.5 ■ Frequent – slight ravelling ■ Intermittent – slight longitudinal cracking ■ Intermittent – slight transverse cracking
Section 14 **Dundas St E (Hwy 2)** **From Fothergill Ct to Jeffrey St** **~0.5 km (Whitby)** This section consists of an urban cross section with four lanes (two per direction), and occasional left turn lanes.	■ PCR = 70 and RCR = 7.0 ■ Frequent – slight to moderate ravelling ■ Frequent – slight flushing ■ Frequent – slight wheel track rutting ■ Extensive – slight longitudinal cracking ■ Frequent – slight transverse cracking ■ Frequent – slight map cracking ■ Intermittent – moderate alligator cracking ■ Manual patching <20% ■ Machine patching <20% ■ Crack rout and seal >50%
Section 15 **Dundas St E (Hwy 2)** **From Jeffrey St to Annes St** **~0.8 km (Whitby)** This section consists of an urban cross section with four lanes (two per direction), and a shared left turn lane.	■ PCR = 85 and RCR = 8.5 ■ Intermittent – slight longitudinal cracking ■ Intermittent – slight transverse cracking

Section	Distresses
Section 16 **Dundas St E (Hwy 2)** **From Annes St to Brock St** **~0.8 km (Whitby)** This section consists of an urban cross section with four lanes (two per direction), and occasional left turn lanes.	■ PCR = 65 and RCR = 6.5 ■ Frequent – moderate ravelling ■ Intermittent – slight flushing ■ Intermittent – moderate potholes ■ Intermittent – moderate pavement edge breaks ■ Extensive – slight wheel track rutting ■ Frequent – slight to moderate longitudinal cracking ■ Frequent – slight to moderate transverse cracking ■ Intermittent – slight map cracking ■ Intermittent – moderate to severe alligator cracking ■ Manual patching <20% ■ Crack rout and seal between 20% and 50%
Section 17 **Dundas St E (Hwy 2)** **From Brock St to Hickory St** **~0.4 km (Whitby)** This section consists of an urban cross section with four lanes (two per direction), and occasional left turn lanes.	■ PCR = 85 and RCR = 8.5 ■ Intermittent – slight flushing ■ Intermittent – slight transverse cracking
Section 18 **Dundas St E (Hwy 2)** **From Hickory St to Garrard Rd** **~2.9 km (Whitby)** This section consists of an urban cross section with four lanes (two per direction), and a shared left turn lane.	■ PCR = 70 and RCR = 7.0 ■ Intermittent – slight ravelling ■ Intermittent – slight flushing ■ Intermittent – severe rippling ■ Extensive – slight wheel track rutting ■ Intermittent – slight utility trench distortion ■ Extensive – slight to moderate longitudinal cracking ■ Extensive – slight to moderate transverse cracking ■ Extensive – slight map cracking ■ Intermittent – moderate alligator cracking ■ Manual patching <20% ■ Machine patching between 20% and 50% ■ Crack rout and seal between 20% and 50%

Section	Distresses
Section 19 **King St E (Eastbound Only) (Hwy 2)** **From Garrard Rd to Simcoe St** **~3.3 km (Oshawa)** This section consists of an urban cross section with four lanes (two per direction), and a shared left turn lane. King St E splits into a divided urban section east of Waverly St E.	■ PCR = 55 and RCR = 5.5 ■ Intermittent – slight ravelling ■ Intermittent – slight flushing ■ Intermittent – moderate pavement edge breaks ■ Extensive – slight to moderate wheel track rutting ■ Intermittent – slight utility trench distortion ■ Extensive – moderate to severe longitudinal cracking ■ Extensive – moderate to severe transverse cracking ■ Extensive – moderate map cracking ■ Frequent – moderate to severe alligator cracking ■ Manual patching <20% ■ Machine patching between 20% and 50% ■ Crack rout and seal between 20% and 50%
Section 20 **Bond St W (Westbound Only) (Hwy 2)** **From Simcoe St to Garrard St** **~3.3 km (Oshawa)** This section consists of a divided urban cross section with three westbound lanes. Bond St W transitions to King St E at the terminus of the divided section east of Waverly St E. West of the divided section, King St E consists of an urban cross section with four lanes (two per direction), and a shared left turn lane.	■ PCR = 55 and RCR = 5.5 ■ Intermittent – slight ravelling ■ Intermittent – slight flushing ■ Intermittent – moderate pavement edge breaks ■ Extensive – slight to moderate wheel track rutting ■ Intermittent – slight utility trench distortion ■ Extensive – moderate to severe longitudinal cracking ■ Extensive – moderate to severe transverse cracking ■ Extensive – moderate map cracking ■ Frequent – moderate to severe alligator cracking ■ Manual patching <20% ■ Machine patching between 20% and 50% ■ Crack rout and seal between 20% and 50%

The observations listed above have also been summarized on the “Flexible Pavement Condition Evaluation Form” in Appendix A.

4.0 PAVEMENT DESIGN AND ANALYSIS

The design analyses for pavement widening were carried out using the “AASHTO Guide for Design of Pavement Structures 1993” and MTO’s “Adaption and Verification of AASHTO Pavement Design Guide for Ontario Conditions, MI-183”, dated March 2008.

4.1 Traffic Data

The data provided by IBI Group in an email dated August 24, 2021, were used to estimate the Equivalent Single Axle Loads (ESALs) and carry out the pavement design analyses. A summary of the traffic data is provided in Table 4 below.

Table 4: Traffic Volumes for Ellesmere Road and Highway 2

Section	AADT	Growth Rate (%)	Commercial (%)
Section 1 Ellesmere Rd – From McCowan Rd to Markham Rd	32,288 (2019) 33,588 (2031) 34,488 (2041)	0.3 0.3	4.8
Section 2 Ellesmere Rd – From Markham Rd to Military Trail	28,669 (2019) 30,369 (2031) 31,569 (2041)	0.5 0.4	4.8
Section 3 Ellesmere Rd – From Military Trail to Morningside Ave	21,815 (2019) 23,515 (2031) 24,715 (2041)	0.6 0.5	4.8
Section 4 Ellesmere Rd – From Morningside Ave to Kingston Rd	14,174 (2019) 16,274 (2031) 17,774 (2041)	1.2 0.9	4.8
Section 5 Kingston Rd – From Hwy 401 to the CN Rail	41,445 (2019) 43,445 (2031) 44,945 (2041)	0.4 0.3	6.0
Section 6 Kingston Rd – From the CN Rail to Liverpool Rd	32,651 (2019) 36,051 (2031) 37,851 (2041)	0.8 0.5	2.3
Section 7 Kingston Rd – From Liverpool Rd to Glengrove Rd	33,230 (2018) 35,530 (2031) 36,830 (2041)	0.5 0.4	3.6
Section 8 Kingston Rd – From Glengrove Rd to Royal Rd	33,230 (2018) 35,530 (2031) 36,830 (2041)	0.5 0.4	3.6
Section 9 Kingston Rd – From Royal Rd to Southview Dr	32,806 (2018) 35,406 (2031) 36,806 (2041)	0.6 0.4	2.9

Section	AADT	Growth Rate (%)	Commercial (%)
Section 10 Kingston Rd – From Southview Dr to Rotherglen Rd S	44,338 (2018) 46,238 (2031) 47,238 (2041)	0.3 0.2	3.2
Section 11 Kingston Rd – From Rotherglen Rd S to Salem Rd	35,246 (2018) 36,346 (2031) 37,046 (2041)	0.2 0.2	2.3
Section 12 Kingston Rd – From Salem Rd to Lakeridge Rd	35,246 (2018) 36,346 (2031) 37,046 (2041)	0.2 0.2	2.3
Section 13 Dundas St E – From Lakeridge Rd to Fothergill Ct	27,849 (2018) 29,949 (2031) 31,749 (2041)	0.6 0.6	2.8
Section 14 Dundas St E – From Fothergill Ct to Jeffrey St	27,849 (2018) 29,949 (2031) 31,749 (2041)	0.6 0.6	2.8
Section 15 Dundas St E – From Jeffrey St to Annes St	27,849 (2018) 29,949 (2031) 31,749 (2041)	0.6 0.6	2.6
Section 16 Dundas St E – From Annes St to Brock St	27,849 (2018) 28,649 (2031) 29,249 (2041)	0.2 0.2	1.9
Section 17 Dundas St E – From Brock St to Hickory St	27,849 (2018) 28,649 (2031) 29,349 (2041)	0.2 0.2	2.8
Section 18 Dundas St E – From Hickory St to Garrard Rd	20,872 (2018) 21,472 (2031) 21,972 (2041)	0.2 0.2	2.3
Sections 19 and 20 King St W – From Garrard St to Simcoe St	20,608 (2018) 21,708 (2031) 22,708 (2041)	0.4 0.5	3.4 2.9

4.2 ESAL Calculations

The flexible pavement designs for pavement widening were carried out for a service life of 19 years. The estimated Equivalent Single Axle Loads (ESALs) for the widening of the various road sections within the project limits are provided in Table 5 below.

Table 5: Equivalent Single Axle Loads

Section	ESAL
Section 1: Ellesmere Rd – From McCowan Rd to Markham Rd	6.0×10^6
Section 2: Ellesmere Rd – From Markham Rd to Military Trail	5.5×10^6
Section 3: Ellesmere Rd – From Military Trail to Morningside Ave	4.3×10^6
Section 4: Ellesmere Rd – From Morningside Ave to Kingston Rd	3.1×10^6
Section 5: Kingston Rd – From Hwy 401 to the CN Rail	9.7×10^6
Section 6: Kingston Rd – From the CN Rail to Liverpool Rd	3.1×10^6
Section 7: Kingston Rd – From Liverpool Rd to Glengrove Rd	4.8×10^6
Section 8: Kingston Rd – From Glengrove Rd to Royal Rd	4.8×10^6
Section 9: Kingston Rd – From Royal Rd to Southview Dr	3.9×10^6
Section 10: Kingston Rd – From Southview Dr to Rotherglen Rd S	5.5×10^6
Section 11: Kingston Rd – From Rotherglen Rd S to Salem Rd	2.7×10^6
Section 12: Kingston Rd – From Salem Rd to Lakeridge Rd	4.1×10^6
Section 13: Dundas St E – From Lakeridge Rd to Fothergill Ct	3.2×10^6
Section 14: Dundas St E – From Fothergill Ct to Jeffrey St	3.2×10^6
Section 15: Dundas St E – From Jeffrey St to Annes St	2.9×10^6
Section 16: Dundas St E – From Annes St to Brock St	2.0×10^6
Section 17: Dundas St E – From Brock St to Hickory St	3.0×10^6
Section 18: Dundas St E – From Hickory St to Garrard Rd	1.8×10^6
Sections 19 and 20: King St W – From Garrard St to Simcoe St	2.4×10^6

4.3 Design Parameters

The flexible pavement design parameters selected for pavement rehabilitation/realignment are listed in Table 6.

Table 6: AASHTO Parameters Selected for Flexible Pavement Design

Parameters		Urban Minor Arterial
Initial Serviceability		4.4
Terminal Serviceability		2.4
Reliability Level (%)		90
Overall Standard Deviation		0.49
Subgrade Resilient Modulus (kPa)		30,000
Structural / Drainage Coefficients	**New HMA**	0.42 / 1.0
	New Granular A	0.14 / 1.0
	New Granular B, Type II	0.09 / 1.0

5.0 PAVEMENT DESIGN RECOMMENDATIONS

5.1 Pavement Rehabilitation Designs

This section provides pavement rehabilitation recommendations for this assignment. It is important to note that the rehabilitation recommendations provided for the existing lanes in Table 7 below are based on the results of the PCA only, and does not consider the pavement structure layer thicknesses (As boreholes were not advanced as part of this study, the pavement structure information was not available). As such, the existing and required layer thicknesses should be confirmed during the detailed design of this project.

The pavement design recommendations for the rehabilitation of each section are provided in Table 7.

Table 7: Recommended Rehabilitation Strategies for the DS BRT

Section	PCA	Recommendation	Lift Thicknesses
Sections 1, 3, 5, 6, 7, 8, 9, 11, 13, 15, 17	>= 75	Mill 50 mm / Pave 50 mm	50 mm SP 12.5 FC2
Sections 2, 10, 12, 14, 16, 18	>=65 & <75	Mill 100 mm / Pave 100 mm	50 mm SP 12.5 FC2 50 mm SP 19.0
Sections 4, 19, 20	<65	Mill/Excavate 150 mm / Pave 150 mm	50 mm SP 12.5 FC2 2 x 50 mm SP 19.0

5.2 Pavement Widening Designs

The pavement design recommendations for the widening of each section are provided in Table 8.

Table 8: Recommended Widening Strategies for the DS BRT

Section	Recommendation		HMA Lift Thicknesses
	Layer	Thickness (mm)	
Section 1: Ellesmere Rd – From McCowan Rd to Markham Rd	HMA	160	SP 12.5 FC2 – 40 mm SP 19.0 – 2 x 60 mm
	Granular A Base	150	
	Granular B Type I Subbase	550	
Section 2: Ellesmere Rd – From Markham Rd to Military Trail	HMA	160	SP 12.5 FC2 – 40 mm SP 19.0 – 2 x 60 mm
	Granular A Base	150	
	Granular B Type I Subbase	550	
Section 3: Ellesmere Rd – From Military Trail to Morningside Ave	HMA	150	SP 12.5 FC2 – 40 mm SP 19.0 – 50 mm + 60 mm
	Granular A Base	150	
	Granular B Type I Subbase	550	
Section 4: Ellesmere Rd – From Morningside Ave to Kingston Rd	HMA	150	SP 12.5 FC2 – 40 mm SP 19.0 – 50 mm + 60 mm
	Granular A Base	150	
	Granular B Type I Subbase	450	
Section 5: Kingston Rd – From Hwy 401 to the CN Rail	HMA	160	SP 12.5 FC2 – 40 mm SP 19.0 – 60 mm + 70 mm
	Granular A Base	250	
	Granular B Type I Subbase	500	
Section 6: Kingston Rd – From the CN Rail to Liverpool Rd	HMA	160	SP 12.5 FC2 – 40 mm SP 19.0 – 50 mm + 60 mm
	Granular A Base	250	
	Granular B Type I Subbase	300	
Section 7: Kingston Rd – From Liverpool Rd to Glengrove Rd	HMA	160	SP 12.5 FC2 – 40 mm SP 19.0 – 2 x 60 mm
	Granular A Base	250	

Section	Recommendation		HMA Lift Thicknesses
	Layer	Thickness (mm)	
	Granular B Type I Subbase	350	
Section 8: Kingston Rd – From Glengrove Rd to Royal Rd	HMA	160	SP 12.5 FC2 – 40 mm SP 19.0 – 2 x 60 mm
	Granular A Base	250	
	Granular B Type I Subbase	350	
Section 9: Kingston Rd – From Royal Rd to Southview Dr	HMA	160	SP 12.5 FC2 – 40 mm SP 19.0 – 50 mm + 60 mm
	Granular A Base	250	
	Granular B Type I Subbase	300	
Section 10: Kingston Rd – From Southview Dr to Rotherglen Rd S	HMA	160	SP 12.5 FC2 – 40 mm SP 19.0 – 2 x 60 mm
	Granular A Base	250	
	Granular B Type I Subbase	400	
Section 11: Kingston Rd – From Rotherglen Rd S to Salem Rd	HMA	160	SP 12.5 FC2 – 40 mm SP 19.0 – 50 mm + 60 mm
	Granular A Base	250	
	Granular B Type I Subbase	300	
Section 12: Kingston Rd – From Salem Rd to Lakeridge Rd	HMA	160	SP 12.5 FC2 – 40 mm SP 19.0 – 50 mm + 60 mm
	Granular A Base	250	
	Granular B Type I Subbase	300	
Section 13: Dundas St E – From Lakeridge Rd to Fothergill Ct	HMA	160	SP 12.5 FC2 – 40 mm SP 19.0 – 50 mm + 60 mm
	Granular A Base	250	
	Granular B Type I Subbase	300	
Section 14: Dundas St E – From Fothergill Ct to Jeffrey St	HMA	160	SP 12.5 FC2 – 40 mm SP 19.0 – 50 mm + 60 mm
	Granular A Base	250	
	Granular B Type I Subbase	300	

Section	Recommendation		HMA Lift Thicknesses
	Layer	Thickness (mm)	
Section 15: Dundas St E – From Jeffrey St to Annes St	HMA	160	SP 12.5 FC2 – 40 mm SP 19.0 – 50 mm + 60 mm
	Granular A Base	250	
	Granular B Type I Subbase	300	
Section 16: Dundas St E – From Annes St to Brock St	HMA	160	SP 12.5 FC2 – 40 mm SP 19.0 – 2 x 50 mm
	Granular A Base	250	
	Granular B Type I Subbase	300	
Section 17: Dundas St E – From Brock St to Hickory St	HMA	160	SP 12.5 FC2 – 40 mm SP 19.0 – 50 mm + 60 mm
	Granular A Base	250	
	Granular B Type I Subbase	300	
Section 18: Dundas St E – From Hickory St to Garrard Rd	HMA	160	SP 12.5 FC2 – 40 mm SP 19.0 – 2 x 50 mm
	Granular A Base	250	
	Granular B Type I Subbase	300	
Sections 19 and 20: King St W – From Garrard St to Simcoe St	HMA	160	SP 12.5 FC2 – 40 mm SP 19.0 – 50 mm + 60 mm
	Granular A Base	250	
	Granular B Type I Subbase	300	

The pavement designs provided in Table 8 for the widening have been checked against the City of Toronto's minimum requirement (150 mm HMA, 150 mm Granular A Base and 200 mm Granular B Type Subbase) for Sections 1 to 4 and against the Region of Durham's minimum requirements (160 mm HMA, and 250 mm Granular A Base) for Sections 5 to 20. The recommended pavement designs satisfy these minimum requirements.

Based on the anticipated ESALs, the Traffic Category for the sections along the DS BRT will be Category D or E. It is recommended that PG 64-28 asphalt cement be used for all mixes; however, it is recommended the surface course mixes (with the exception of the red asphalt) be increased to PG 70-28 in accordance with the applicable standards at the time of Tender preparation.

6.0 RED ASPHALT PAVEMENTS

Coloured pavements have been used to delineate dedicated lanes for bus rapid transit in the Region of York and a number of other municipalities in North America. There are a number of different methods to obtain coloured pavements including the following:

1. Epoxy based paints;
2. Thermoplastic Coatings;
3. Hot Mix Asphalt (HMA) with coloured pigments, conventional asphalt cement, and conventional aggregates or coloured aggregates;
4. HMA with synthetic asphalt cements with coloured aggregates.

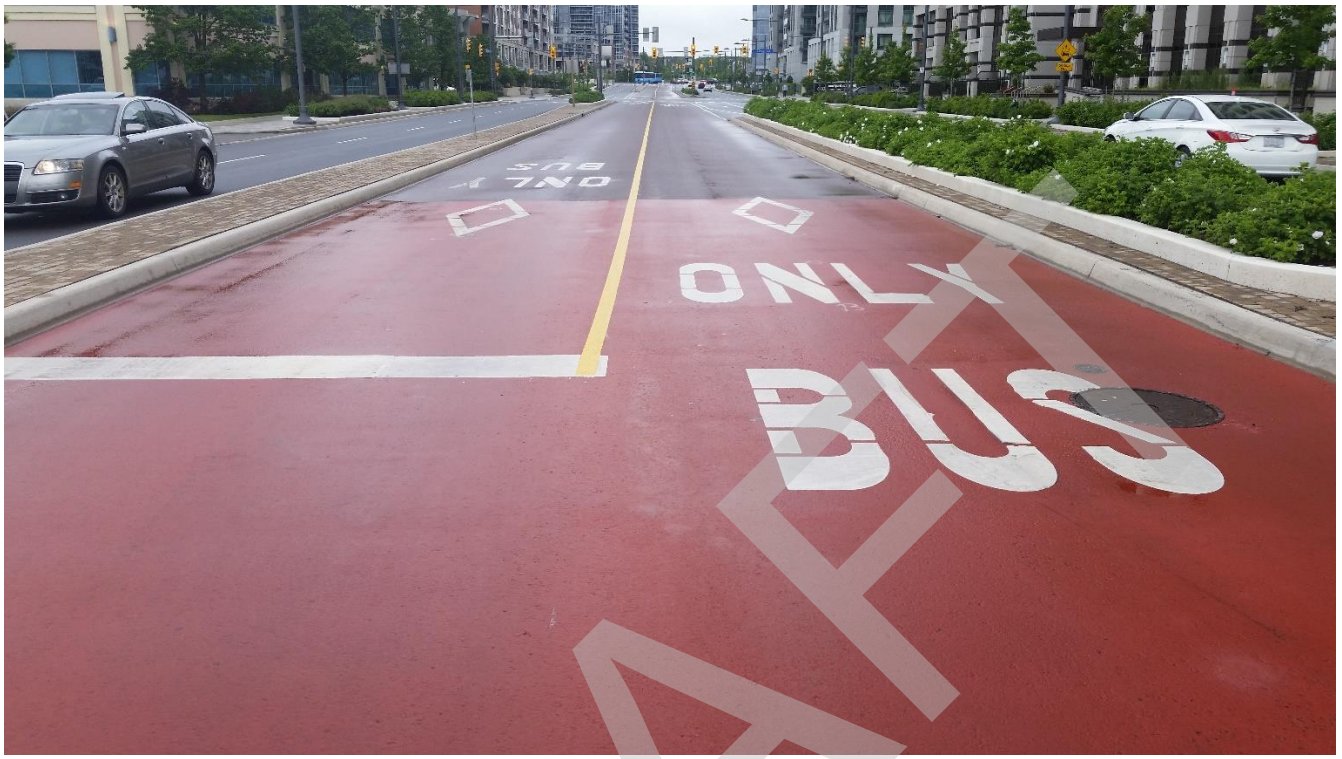
We are not aware of a comprehensive study carried out to compare the field performance of the various methods used to achieve coloured pavement. However, anecdotal evidence indicates that paints and coatings are not as durable, especially when subjected to heavy traffic such as on Bus Rapid Transit (BRT) lanes. In addition, cold weather and repeated wetting and drying cycles can also reduce the durability of paints and thermoplastic coatings used to colour the BRT Lanes.

The Hot Mix Asphalt based methods listed in 3 and 4 above have performed satisfactorily, but the grade of the asphalt cement used in these mixes has to be selected with care as the pigment can react with the asphalt cement resulting in premature aging of the surface course HMA. Generally, synthetic asphalt cements are expensive and can add $150 – $200 to the cost of a tonne of conventional HMA. As such, HMA with synthetic asphalt cements is generally used on smaller projects to add aesthetic value. Due to the cost of pigments and special aggregates, coloured HMA mixes with conventional asphalt cements generally cost $ 75 - $100 more than conventional surface course HMA mixes.

Previous projects have incorporated granitic aggregates with 2.5 to 3.0% red pigment (ferric oxide) to produce a red-coloured asphalt. However, mineral fillers or other materials may be used and the contractor is encouraged to improve the brightness of the HMA by carrying out performance testing on the red asphalt mixes to evaluate the life cycle of the red asphalt mix compared to a conventional HMA. In addition, the contractor should also try different asphalt cement grades that will produce the best results during the performance testing. Previous projects have found that PG 70-34 performed satisfactorily with the materials used in the asphalt mix provided on those projects.

The red asphalt HMA should satisfy the material requirements of OPSS.MUNI 1151 and testing to evaluate the mix's resistance to rutting. This could be carried out by the Hamburg Wheel-track test in accordance with AASHTO T 324-19, or a similar test using an Asphalt Pavement Analyzer (APA) in accordance with AASHTO TP 63-09.

The colour of the red asphalt must be similar or better (brighter) than the red asphalt pavement placed on the VivaNext projects in York Region (see photo below). The brightness of the red asphalt is to clearly differenttiate between the bus lanes and the general purpose lanes. The Region and/or the City have the right to reject the Red Asphalt mix based on the brightness. The Design-Builder shall submit samples of the red asphalt for review and approval before carrying out any paving.



Photograph of Red Asphalt Mix produced on the VivaNext Bus Rapid Transit Project in York Region

Closure

We trust this memo is sufficient for your current needs. Should you have any questions or if clarifications are required, please do not hesitate to contact our office.

Yours truly,

Golder Associates Ltd.

DRAFT

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GBG/ACB/gbg;rl

Appendix A: Flexible Pavement Condition Evaluation Forms (Municipalities)

Appendix B: ESALs and AASHTO

https://golderassociates.sharepoint.com/sites/148821/project files/6 deliverables/pavements/21473923 mem draft revb 2021'12'24 pcs destop review pavement design - dbrt.docx

APPENDIX A

Flexible Pavement Condition Evaluation Forms

FLEXIBLE PAVEMENT CONDITION EVALUATION FORM (MUNICIPALITIES)

Road No. (Street) Ellesmere Road **Location From** McCowan Road **To** Markham Road

Section Length 1.7 (KM) **Survey Date** August 24, 2021 **Traffic Direction** B (B: Both Directions, N: North Bound, S: South Bound, E: East Bound, W: West Bound)

Contract No. - **Work Project No.** - **Class** A (F: Freeway, C: Connecting Link, A: Major Artierial, M: Minor Artierial, R: Residential)

Pavement Condition Rating (PCR) 85 **Riding Condition Rating (RCR)** 8.5 **Evaluated by** GBG

Riding Condition Rating (At Posted Speed)

10	8	6	4	2	0
Excellent	Good	Fair	Poor	Very Poor	
Smooth and Pleasant	Comfort-able	Uncomfort-able	Very Rough and Bumpy	Dangerous at Posted Speed	

Pavement Distress Manifestation			Severity of Distress: Slight (1)	Moderate (2)	Severe (3)	Density of Distress % Extent of Occurrence: Intermittent (<20, 1)	Frequent (20-50, 2)	Extensive (>50, 3)
Surface Defects	Ravelling	1						
	Flushing	2	X			X		
	Potholes	3						
	Pavement Edge Breaks	4						
	Manholes and Catchbasins	5	X			X		
Surface Deformation	Rippling and Shoving	6						
	Wheel Track Rutting	7						
	Distortion	8						
	Utility Trenches	9						
Cracking	Longitudinal	10	X			X		
	Transverse	11	X			X		
	Pavement Edge	12						
	Map	13						
	Alligator	14						

Distress Comments (Items not covered above)

Recommendation by Evaluator

Shoulder Distress Manifestation: Dominant Type	one	Distress	Severity of Distress: Right Sli (1)	Right Mod (2)	Right Sev (3)	Left Sli (1)	Left Mod (2)	Left Sev (3)	Density of Distress % Extent of Occurrence: Right <20 (1)	Right 20-50 (2)	Right >50 (3)	Left <20 (1)	Left 20-50 (2)	Left >50 (3)
Paved Full		Pavement Edge Paved Shoulder Separation												
Paved Partial		Cracking												
Surface Treated		Breakup and Potholes												
		Distortion												
Primed		Pavement Edge Curb Separation												

Curb and Gutter

Maitenance Treatment: Pavement	Extent of Occurrence %: <20 (1)	20-50 (2)	>50 (3)	Shoulder	Extent of Occurrence %: <20 (1)	20-50 (2)	>50 (3)
Manual Patching				Manual patching			
Machine Patching				Manual Spray Patching			
Manual Spray patching				Manual Chip Seal			
Manual Chip Seal				Crack Rout and Seal			
Machine Chip Seal							
Fog Seal							
Surface Treatment							
Manual Burn & Seal							
Crack Rout and Seal							

FLEXIBLE PAVEMENT CONDITION EVALUATION FORM (MUNICIPALITIES)

Road No. (Street) Ellesmere Road **Location From** Markham Road **To** Military Trail

Section Length 1.2 (KM) **Survey Date** August 24, 2021 **Traffic Direction** B (B: Both Directions, N: North Bound, S: South Bound, E: East Bound, W: West Bound)

Contract No. - **Work Project No.** - **Class** A (F: Freeway, C: Connecting Link, A: Major Artierial, M: Minor Artierial, R: Residential)

Pavement Condition Rating (PCR) 65 **Riding Condition Rating (RCR)** 6.5 **Evaluated by** GBG

Riding Condition Rating (At Posted Speed)

10	8	6	4	2	0
Excellent	Good	Fair	Poor	Very Poor	
Smooth and Pleasant	Comfort-able	Uncomfort-able	Very Rough and Bumpy	Dangerous at Posted Speed	

Pavement Distress Manifestation			Severity of Distress: Slight (1)	Moderate (2)	Severe (3)	Density of Distress % Extent of Occurrence: Intermittent (<20, 1)	Frequent (20-50, 2)	Extensive (>50, 3)
Surface Defects	Ravelling	1		X			X	
	Flushing	2	X			X		
	Potholes	3		X		X		
	Pavement Edge Breaks	4			X	X		
	Manholes and Catchbasins	5		X		X		
Surface Deformation	Rippling and Shoving	6						
	Wheel Track Rutting	7	X					X
	Distortion	8						
	Utility Trenches	9		X		X		
Cracking	Longitudinal	10			X		X	
	Transverse	11		X	X		X	
	Pavement Edge	12			X	X		
	Map	13						
	Alligator	14		X		X		

Distress Comments (Items not covered above)

Recommendation by Evaluator

Shoulder Distress Manifestation: Dominant Type	one	Distress	Severity of Distress: Right Sli (1)	Right Mod (2)	Right Sev (3)	Left Sli (1)	Left Mod (2)	Left Sev (3)	Density of Distress % Extent of Occurrence: Right <20 (1)	Right 20-50 (2)	Right >50 (3)	Left <20 (1)	Left 20-50 (2)	Left >50 (3)
Paved Full		Pavement Edge Paved Shoulder Separation												
Paved Partial		Cracking												
Surface Treated		Breakup and Potholes												
Primed		Distortion												
		Pavement Edge Curb Separation												

Curb and Gutter

Maitenance Treatment

Pavement	Extent of Occurrence %: <20 (1)	20-50 (2)	>50 (3)	Shoulder	Extent of Occurrence %: <20 (1)	20-50 (2)	>50 (3)
Manual Patching	X			Manual patching			
Machine Patching				Manual Spray Patching			
Manual Spray patching				Manual Chip Seal			
Manual Chip Seal				Crack Rout and Seal			
Machine Chip Seal							
Fog Seal							
Surface Treatment							
Manual Burn & Seal							
Crack Rout and Seal	X						

FLEXIBLE PAVEMENT CONDITION EVALUATION FORM (MUNICIPALITIES)

Road No. (Street) Ellesmere Road **Location From** Military Trail **To** Morningside Avenue

Section Length 2.0 (KM) **Survey Date** August 24, 2021 **Traffic Direction** B (B: Both Directions, N: North Bound, S: South Bound, E: East Bound, W: West Bound)

Contract No. - **Work Project No.** - **Class** A (F: Freeway, C: Connecting Link, A: Major Artierial, M: Minor Artierial, R: Residential)

Pavement Condition Rating (PCR) 85 **Riding Condition Rating (RCR)** 8.5 **Evaluated by** GBG

Riding Condition Rating (At Posted Speed)

10	8	6	4	2	0
Excellent	Good	Fair	Poor	Very Poor	
Smooth and Pleasant	Comfort-able	Uncomfort-able	Very Rough and Bumpy	Dangerous at Posted Speed	

Pavement Distress Manifestation			Severity of Distress: Slight (1)	Moderate (2)	Severe (3)	Density of Distress % Extent of Occurrence: Intermittent (<20, 1)	Frequent (20-50, 2)	Extensive (>50, 3)
Surface Defects	Ravelling	1						
	Flushing	2	X			X		
	Potholes	3						
	Pavement Edge Breaks	4						
	Manholes and Catchbasins	5	X			X		
Surface Deformation	Rippling and Shoving	6						
	Wheel Track Rutting	7						
	Distortion	8						
	Utility Trenches	9						
Cracking	Longitudinal	10	X			X		
	Transverse	11	X			X		
	Pavement Edge	12						
	Map	13						
	Alligator	14						

Distress Comments (Items not covered above)

Recommendation by Evaluator

Shoulder Distress Manifestation: Dominant Type	one	Distress	Severity of Distress: Right Sli (1)	Right Mod (2)	Right Sev (3)	Left Sli (1)	Left Mod (2)	Left Sev (3)	Density of Distress % Extent of Occurrence: Right <20 (1)	Right 20-50 (2)	Right >50 (3)	Left <20 (1)	Left 20-50 (2)	Left >50 (3)
Paved Full		Pavement Edge Paved Shoulder Separation												
Paved Partial		Cracking												
Surface Treated		Breakup and Potholes												
Primed		Distortion												
		Pavement Edge Curb Separation												

Curb and Gutter

Maitenance Treatment

Pavement	Extent of Occurrence %: <20 (1)	20-50 (2)	>50 (3)	Shoulder	Extent of Occurrence %: <20 (1)	20-50 (2)	>50 (3)
Manual Patching				Manual patching			
Machine Patching	X			Manual Spray Patching			
Manual Spray patching				Manual Chip Seal			
Manual Chip Seal				Crack Rout and Seal			
Machine Chip Seal							
Fog Seal							
Surface Treatment							
Manual Burn & Seal							
Crack Rout and Seal							

FLEXIBLE PAVEMENT CONDITION EVALUATION FORM (MUNICIPALITIES)

Road No. (Street) Ellesmere Road **Location From** Morningside Avenue **To** Kingston Road (Extending to Highway 401)

Section Length 3.5 (KM) **Survey Date** August 24, 2021 **Traffic Direction** B (B: Both Directions, N: North Bound, S: South Bound, E: East Bound, W: West Bound)

Contract No. - **Work Project No.** - **Class** A (F: Freeway, C: Connecting Link, A: Major Arterial, M: Minor Arterial, R: Residential)

Pavement Condition Rating (PCR) 60 **Riding Condition Rating (RCR)** 6.0 **Evaluated by** GBG

Riding Condition Rating (At Posted Speed)

10	8	6	4	2	0
Excellent	Good	Fair	Poor	Very Poor	
Smooth and Pleasant	Comfort-able	Uncomfort-able	Very Rough and Bumpy	Dangerous at Posted Speed	

Pavement Distress Manifestation			Severity of Distress: Slight (1)	Moderate (2)	Severe (3)	Density of Distress % Extent of Occurrence: Intermittent (<20) (1)	Frequent (20-50) (2)	Extensive (>50) (3)
Surface Defects	Ravelling	1		X			X	
	Flushing	2	X			X		
	Potholes	3		X		X		
	Pavement Edge Breaks	4		X		X		
	Manholes and Catchbasins	5		X		X		
Surface Deformation	Rippling and Shoving	6						
	Wheel Track Rutting	7		X			X	
	Distortion	8						
	Utility Trenches	9		X		X		
Cracking	Longitudinal	10		X	X			X
	Transverse	11		X	X		X	
	Pavement Edge	12			X	X		
	Map	13		X			X	
	Alligator	14		X	X		X	

Distress Comments (Items not covered above)

Recommendation by Evaluator

Shoulder Distress Manifestation			Severity of Distress: Right Sli (1)	Right Mod (2)	Right Sev (3)	Left Sli (1)	Left Mod (2)	Left Sev (3)	Density of Distress % Extent of Occurrence: Right <20 (1)	Right 20-50 (2)	Right >50 (3)	Left <20 (1)	Left 20-50 (2)	Left >50 (3)
Dominant Type	one	Distress												
Paved Full		Pavement Edge Paved Shoulder Separation												
Paved Partial		Cracking												
Surface Treated		Breakup and Potholes												
Primed		Distortion												
		Pavement Edge Curb Separation												

Curb and Gutter

Maitenance Treatment: Pavement	Extent of Occurrence % <20 (1)	20-50 (2)	>50 (3)	Shoulder	Extent of Occurrence % <20 (1)	20-50 (2)	>50 (3)
Manual Patching	X			Manual patching			
Machine Patching		X		Manual Spray Patching			
Manual Spray patching				Manual Chip Seal			
Manual Chip Seal				Crack Rout and Seal			
Machine Chip Seal							
Fog Seal							
Surface Treatment							
Manual Burn & Seal							
Crack Rout and Seal	X						

FLEXIBLE PAVEMENT CONDITION EVALUATION FORM (MUNICIPALITIES)

Road No. (Street) Kingston Road **Location From** Highway 401 **To** CN Rail

Section Length 5.3 (KM) **Survey Date** August 24, 2021 **Traffic Direction** B (B: Both Directions, N: North Bound, S: South Bound, E: East Bound, W: West Bound)

Contract No. - **Work Project No.** - **Class** A (F: Freeway, C: Connecting Link, A: Major Arterial, M: Minor Arterial, R: Residential)

Pavement Condition Rating (PCR) 80 **Riding Condition Rating (RCR)** 8.0 **Evaluated by** GBG

Riding Condition Rating (At Posted Speed)

10	8	6	4	2	0
Excellent	Good	Fair	Poor	Very Poor	
Smooth and Pleasant	Comfort-able	Uncomfort-able	Very Rough and Bumpy	Dangerous at Posted Speed	

Pavement Distress Manifestation			Severity of Distress: Slight (1)	Moderate (2)	Severe (3)	Density of Distress % Extent of Occurrence: Intermittent (<20, 1)	Frequent (20-50, 2)	Extensive (>50, 3)
Surface Defects	Ravelling	1	X			X		
	Flushing	2	X			X		
	Potholes	3			X	X		
	Pavement Edge Breaks	4						
	Manholes and Catchbasins	5	X			X		
Surface Deformation	Rippling and Shoving	6						
	Wheel Track Rutting	7	X			X		
	Distortion	8						
	Utility Trenches	9	X			X		
Cracking	Longitudinal	10	X			X		
	Transverse	11	X			X		
	Pavement Edge	12		X		X		
	Map	13	X			X		
	Alligator	14						

Shoulder Distress Manifestation			Severity of Distress: Right Sli (1)	Right Mod (2)	Right Sev (3)	Left Sli (1)	Left Mod (2)	Left Sev (3)	Density of Distress % Extent of Occurrence: Right <20 (1)	Right 20-50 (2)	Right >50 (3)	Left <20 (1)	Left 20-50 (2)	Left >50 (3)
Dominant Type	one	Distress												
Paved Full		Pavement Edge Paved Shoulder Separation												
Paved Partial		Cracking												
Surface Treated		Breakup and Potholes												
Primed		Distortion												
		Pavement Edge Curb Separation												

Curb and Gutter

Maitenance Treatment								
Pavement	Extent of Occurrence %: <20 (1)	20-50 (2)	>50 (3)	Shoulder	Extent of Occurrence %: <20 (1)	20-50 (2)	>50 (3)
Manual Patching	X			Manual patching			
Machine Patching	X			Manual Spray Patching			
Manual Spray patching				Manual Chip Seal			
Manual Chip Seal				Crack Rout and Seal			
Machine Chip Seal							
Fog Seal							
Surface Treatment							
Manual Burn & Seal							
Crack Rout and Seal	X						

Distress Comments (Items not covered above) Short rural section east of Rosebank Road with pavement edge cracking. Small 0.5 km section at Delta Boulevard in slightly worse condition.

Recommendation by Evaluator

FLEXIBLE PAVEMENT CONDITION EVALUATION FORM (MUNICIPALITIES)

Road No. (Street) Kingston Road **Location From** CN Rail **To** 300 m west of Liverpool Road

Section Length 1.0 (KM) **Survey Date** August 24, 2021 **Traffic Direction** B (B: Both Directions, N: North Bound, S: South Bound, E: East Bound, W: West Bound)

Contract No. - **Work Project No.** - **Class** A (F: Freeway, C: Connecting Link, A: Major Arterial, M: Minor Arterial, R: Residential)

Pavement Condition Rating (PCR) 75 **Riding Condition Rating (RCR)** 7.5 **Evaluated by** GBG

Riding Condition Rating (At Posted Speed)

10	8	6	4	2	0
Excellent	Good	Fair	Poor	Very Poor	
Smooth and Pleasant	Comfort-able	Uncomfort-able	Very Rough and Bumpy	Dangerous at Posted Speed	

Pavement Distress Manifestation			Severity of Distress: Slight (1)	Moderate (2)	Severe (3)	Density of Distress % Extent of Occurrence: Intermittent (<20, 1)	Frequent (20-50, 2)	Extensive (>50, 3)
Surface Defects	Ravelling	1	X				X	
	Flushing	2	X					X
	Potholes	3			X	X		
	Pavement Edge Breaks	4		X		X		
	Manholes and Catchbasins	5	X			X		
Surface Deformation	Rippling and Shoving	6						
	Wheel Track Rutting	7	X				X	
	Distortion	8						
	Utility Trenches	9						
Cracking	Longitudinal	10	X	X			X	
	Transverse	11	X				X	
	Pavement Edge	12	X			X		
	Map	13		X		X		
	Alligator	14	X	X		X		

Distress Comments (Items not covered above) Rural section east of Walnut Lane with pavement edge cracking.

Recommendation by Evaluator

Shoulder Distress Manifestation			Severity of Distress: Right Sli (1)	Right Mod (2)	Right Sev (3)	Left Sli (1)	Left Mod (2)	Left Sev (3)	Density of Distress % Extent of Occurrence: Right <20 (1)	Right 20-50 (2)	Right >50 (3)	Left <20 (1)	Left 20-50 (2)	Left >50 (3)
Dominant Type	one	Distress												
Paved Full		Pavement Edge Paved Shoulder Separation												
Paved Partial		Cracking												
Surface Treated		Breakup and Potholes												
Primed		Distortion												
		Pavement Edge Curb Separation												

Curb and Gutter

Maitenance Treatment

Pavement	Extent of Occurrence %: <20 (1)	20-50 (2)	>50 (3)	Shoulder	Extent of Occurrence %: <20 (1)	20-50 (2)	>50 (3)
Manual Patching	X			Manual patching			
Machine Patching	X			Manual Spray Patching			
Manual Spray patching				Manual Chip Seal			
Manual Chip Seal				Crack Rout and Seal			
Machine Chip Seal							
Fog Seal							
Surface Treatment							
Manual Burn & Seal							
Crack Rout and Seal		X					

FLEXIBLE PAVEMENT CONDITION EVALUATION FORM (MUNICIPALITIES)

Road No. (Street) Kingston Road **Location From** 300 m west of Liverpool Road **To** Glengrove Road

Section Length 1.0 (KM) **Survey Date** August 24, 2021 **Traffic Direction** B (B: Both Directions, N: North Bound, S: South Bound, E: East Bound, W: West Bound)

Contract No. - **Work Project No.** - **Class** A (F: Freeway, C: Connecting Link, A: Major Arterial, M: Minor Arterial, R: Residential)

Pavement Condition Rating (PCR) 85 **Riding Condition Rating (RCR)** 8.5 **Evaluated by** GBG

Riding Condition Rating (At Posted Speed)

10	8	6	4	2	0
Excellent	Good	Fair	Poor	Very Poor	
Smooth and Pleasant	Comfort-able	Uncomfort-able	Very Rough and Bumpy	Dangerous at Posted Speed	

Pavement Distress Manifestation			Severity of Distress: Slight (1)	Moderate (2)	Severe (3)	Density of Distress % Extent of Occurrence: Intermittent (<20) (1)	Frequent (20-50) (2)	Extensive (>50) (3)
Surface Defects	Ravelling	1	X			X		
	Flushing	2	X			X		
	Potholes	3						
	Pavement Edge Breaks	4						
	Manholes and Catchbasins	5	X			X		
Surface Deformation	Rippling and Shoving	6						
	Wheel Track Rutting	7						
	Distortion	8						
	Utility Trenches	9						
Cracking	Longitudinal	10	X			X		
	Transverse	11	X			X		
	Pavement Edge	12						
	Map	13						
	Alligator	14						

Distress Comments (Items not covered above)

Recommendation by Evaluator

Shoulder Distress Manifestation: Dominant Type	one	Distress	Severity of Distress: Right Sli (1)	Right Mod (2)	Right Sev (3)	Left Sli (1)	Left Mod (2)	Left Sev (3)	Density of Distress % Extent of Occurrence: Right <20 (1)	Right 20-50 (2)	Right >50 (3)	Left <20 (1)	Left 20-50 (2)	Left >50 (3)
Paved Full		Pavement Edge Paved Shoulder Separation												
Paved Partial		Cracking												
Surface Treated		Breakup and Potholes												
Primed		Distortion												
		Pavement Edge Curb Separation												

Curb and Gutter

Maitenance Treatment: Pavement	Extent of Occurrence %: <20 (1)	20-50 (2)	>50 (3)	Shoulder	Extent of Occurrence %: <20 (1)	20-50 (2)	>50 (3)
Manual Patching				Manual patching			
Machine Patching				Manual Spray Patching			
Manual Spray patching				Manual Chip Seal			
Manual Chip Seal				Crack Rout and Seal			
Machine Chip Seal							
Fog Seal							
Surface Treatment							
Manual Burn & Seal							
Crack Rout and Seal							

FLEXIBLE PAVEMENT CONDITION EVALUATION FORM (MUNICIPALITIES)

Road No. (Street) Kingston Road **Location From** Glengrove Road **To** Royal Road

Section Length 1.0 (KM) **Survey Date** August 24, 2021 **Traffic Direction** B (B: Both Directions, N: North Bound, S: South Bound, E: East Bound, W: West Bound)

Contract No. - **Work Project No.** - **Class** A (F: Freeway, C: Connecting Link, A: Major Artierial, M: Minor Artierial, R: Residential)

Pavement Condition Rating (PCR) 75 **Riding Condition Rating (RCR)** 7.5 **Evaluated by** GBG

Riding Condition Rating (At Posted Speed)

10	8	6	4	2	0
Excellent	Good	Fair	Poor	Very Poor	
Smooth and Pleasant	Comfort-able	Uncomfort-able	Very Rough and Bumpy	Dangerous at Posted Speed	

Pavement Distress Manifestation			Severity of Distress: Slight (1)	Moderate (2)	Severe (3)	Density of Distress % Extent of Occurrence: Intermittent (<20, 1)	Frequent (20-50, 2)	Extensive (>50, 3)
Surface Defects	Ravelling	1	X			X		
	Flushing	2	X			X		
	Potholes	3		X		X		
	Pavement Edge Breaks	4						
	Manholes and Catchbasins	5	X			X		
Surface Deformation	Rippling and Shoving	6						
	Wheel Track Rutting	7	X			X		
	Distortion	8						
	Utility Trenches	9		X		X		
Cracking	Longitudinal	10	X	X			X	
	Transverse	11	X			X		
	Pavement Edge	12	X	X		X		
	Map	13						
	Alligator	14						

Shoulder Distress Manifestation			Severity of Distress: Right Sli (1)	Right Mod (2)	Right Sev (3)	Left Sli (1)	Left Mod (2)	Left Sev (3)	Density of Distress % Extent of Occurrence: Right <20 (1)	Right 20-50 (2)	Right >50 (3)	Left <20 (1)	Left 20-50 (2)	Left >50 (3)
Dominant Type	one	Distress												
Paved Full		Pavement Edge Paved Shoulder Separation												
Paved Partial		Cracking												
Surface Treated		Breakup and Potholes												
Primed		Distortion												
		Pavement Edge Curb Separation												

Curb and Gutter

Maitenance Treatment: Pavement	Extent of Occurrence % <20 (1)	20-50 (2)	>50 (3)	Shoulder	Extent of Occurrence % <20 (1)	20-50 (2)	>50 (3)
Manual Patching	X			Manual patching			
Machine Patching	X			Manual Spray Patching			
Manual Spray patching				Manual Chip Seal			
Manual Chip Seal				Crack Rout and Seal			
Machine Chip Seal							
Fog Seal							
Surface Treatment							
Manual Burn & Seal							
Crack Rout and Seal	X						

Distress Comments (Items not covered above) Increased pavement edge cracking and general distresses at new development - 1550 Kingston Road.

Pavement between Liverpool Rd and Glengrove Rd in excellent condition.

Recommendation by Evaluator

FLEXIBLE PAVEMENT CONDITION EVALUATION FORM (MUNICIPALITIES)

Road No. (Street) Kingston Road **Location From** Royal Road **To** Southview Drive

Section Length 1.0 (KM) **Survey Date** August 24, 2021 **Traffic Direction** B (B: Both Directions, N: North Bound, S: South Bound, E: East Bound, W: West Bound)

Contract No. - **Work Project No.** - **Class** A (F: Freeway, C: Connecting Link, A: Major Arterial, M: Minor Arterial, R: Residential)

Pavement Condition Rating (PCR) 85 **Riding Condition Rating (RCR)** 8.5 **Evaluated by** GBG

Riding Condition Rating (At Posted Speed)

10	8	6	4	2	0
Excellent	Good	Fair	Poor	Very Poor	
Smooth and Pleasant	Comfort-able	Uncomfort-able	Very Rough and Bumpy	Dangerous at Posted Speed	

Pavement Distress Manifestation			Severity of Distress: Slight (1)	Moderate (2)	Severe (3)	Density of Distress % Extent of Occurrence: Intermittent (<20) (1)	Frequent (20-50) (2)	Extensive (>50) (3)
Surface Defects	Ravelling	1	X			X		
	Flushing	2						
	Potholes	3						
	Pavement Edge Breaks	4						
	Manholes and Catchbasins	5	X			X		
Surface Deformation	Rippling and Shoving	6						
	Wheel Track Rutting	7						
	Distortion	8						
	Utility Trenches	9						
Cracking	Longitudinal	10	X			X		
	Transverse	11	X			X		
	Pavement Edge	12						
	Map	13						
	Alligator	14						

Shoulder Distress Manifestation			Severity of Distress: Right Sli (1)	Right Mod (2)	Right Sev (3)	Left Sli (1)	Left Mod (2)	Left Sev (3)	Density of Distress % Extent of Occurrence: Right <20 (1)	Right 20-50 (2)	Right >50 (3)	Left <20 (1)	Left 20-50 (2)	Left >50 (3)
Dominant Type	one	Distress												
Paved Full		Pavement Edge Paved Shoulder Separation												
Paved Partial		Cracking												
Surface Treated		Breakup and Potholes												
Primed		Distortion												
		Pavement Edge Curb Separation												

Curb and Gutter

Maitenance Treatment								
Pavement	Extent of Occurrence % <20 (1)	20-50 (2)	>50 (3)	Shoulder	Extent of Occurrence % <20 (1)	20-50 (2)	>50 (3)
Manual Patching				Manual patching			
Machine Patching				Manual Spray Patching			
Manual Spray patching				Manual Chip Seal			
Manual Chip Seal				Crack Rout and Seal			
Machine Chip Seal							
Fog Seal							
Surface Treatment							
Manual Burn & Seal							
Crack Rout and Seal							

Distress Comments (Items not covered above)

Recommendation by Evaluator

FLEXIBLE PAVEMENT CONDITION EVALUATION FORM (MUNICIPALITIES)

Road No. (Street) Kingston Road **Location From** Southview Drive **To** Rotherglen Road South

Section Length 1.9 (KM) **Survey Date** August 24, 2021 **Traffic Direction** B (B: Both Directions, N: North Bound, S: South Bound, E: East Bound, W: West Bound)

Contract No. - **Work Project No.** - **Class** A (F: Freeway, C: Connecting Link, A: Major Artierial, M: Minor Artierial, R: Residential)

Pavement Condition Rating (PCR) 65 **Riding Condition Rating (RCR)** 6.5 **Evaluated by** GBG

Riding Condition Rating (At Posted Speed)

10	8	6	4	2	0
Excellent	Good	Fair	Poor	Very Poor	
Smooth and Pleasant	Comfort-able	Uncomfort-able	Very Rough and Bumpy	Dangerous at Posted Speed	

Pavement Distress Manifestation			Severity of Distress: Slight (1)	Moderate (2)	Severe (3)	Density of Distress % Extent of Occurrence: Intermittent (<20, 1)	Frequent (20-50, 2)	Extensive (>50, 3)
Surface Defects	Ravelling	1	X	X		X		
	Flushing	2	X				X	
	Potholes	3						
	Pavement Edge Breaks	4						
	Manholes and Catchbasins	5	X			X		
Surface Deformation	Rippling and Shoving	6						
	Wheel Track Rutting	7	X	X			X	
	Distortion	8						
	Utility Trenches	9	X			X		
Cracking	Longitudinal	10	X	X			X	
	Transverse	11	X			X		
	Pavement Edge	12						
	Map	13						
	Alligator	14		X		X		

Distress Comments (Items not covered above) Aligator cracking generally in wheelpaths.

Recommendation by Evaluator

Shoulder Distress Manifestation			Severity of Distress: Right Sli (1)	Right Mod (2)	Right Sev (3)	Left Sli (1)	Left Mod (2)	Left Sev (3)	Density of Distress % Extent of Occurrence: Right <20 (1)	Right 20-50 (2)	Right >50 (3)	Left <20 (1)	Left 20-50 (2)	Left >50 (3)
Paved Full	one	Pavement Edge Paved Shoulder Separation												
Paved Partial	one	Cracking												
Surface Treated	one	Breakup and Potholes												
Primed	one	Distortion												
	one	Pavement Edge Curb Separation												

Curb and Gutter

Maitenance Treatment: Pavement	Extent of Occurrence % <20 (1)	20-50 (2)	>50 (3)	Shoulder	Extent of Occurrence % <20 (1)	20-50 (2)	>50 (3)
Manual Patching	X			Manual patching			
Machine Patching	X			Manual Spray Patching			
Manual Spray patching				Manual Chip Seal			
Manual Chip Seal				Crack Rout and Seal			
Machine Chip Seal							
Fog Seal							
Surface Treatment							
Manual Burn & Seal							
Crack Rout and Seal			X				

FLEXIBLE PAVEMENT CONDITION EVALUATION FORM (MUNICIPALITIES)

Road No. (Street) Kingston Road **Location From** Rotherglen Road South **To** East of Salem Road

Section Length 2.6 (KM) **Survey Date** August 24, 2021 **Traffic Direction** B (B: Both Directions, N: North Bound, S: South Bound, E: East Bound, W: West Bound)

Contract No. - **Work Project No.** - **Class** A (F: Freeway, C: Connecting Link, A: Major Artierial, M: Minor Artierial, R: Residential)

Pavement Condition Rating (PCR) 80 **Riding Condition Rating (RCR)** 8.0 **Evaluated by** GBG

Riding Condition Rating (At Posted Speed)

10	8	6	4	2	0
Excellent	Good	Fair	Poor	Very Poor	
Smooth and Pleasant	Comfort-able	Uncomfort-able	Very Rough and Bumpy	Dangerous at Posted Speed	

Pavement Distress Manifestation			Severity of Distress: Slight (1)	Moderate (2)	Severe (3)	Density of Distress % Extent of Occurrence: Intermittent (<20, 1)	Frequent (20-50, 2)	Extensive (>50, 3)
Surface Defects	Ravelling	1						
	Flushing	2	X			X		
	Potholes	3						
	Pavement Edge Breaks	4						
	Manholes and Catchbasins	5	X			X		
Surface Deformation	Rippling and Shoving	6						
	Wheel Track Rutting	7	X			X		
	Distortion	8						
	Utility Trenches	9						
Cracking	Longitudinal	10	X				X	
	Transverse	11	X			X		
	Pavement Edge	12						
	Map	13	X			X		
	Alligator	14	X			X		

Distress Comments (Items not covered above) Map cracking present at intersections.

Recommendation by Evaluator

Shoulder Distress Manifestation: Dominant Type	one	Distress	Severity of Distress: Right Sli (1)	Right Mod (2)	Right Sev (3)	Left Sli (1)	Left Mod (2)	Left Sev (3)	Density of Distress % Extent of Occurrence: Right <20 (1)	Right 20-50 (2)	Right >50 (3)	Left <20 (1)	Left 20-50 (2)	Left >50 (3)
Paved Full		Pavement Edge Paved Shoulder Separation												
Paved Partial		Cracking												
Surface Treated		Breakup and Potholes												
Primed		Distortion												
		Pavement Edge Curb Separation												

Curb and Gutter

Maitenance Treatment

Pavement	Extent of Occurrence %: <20 (1)	20-50 (2)	>50 (3)	Shoulder	Extent of Occurrence %: <20 (1)	20-50 (2)	>50 (3)
Manual Patching	X			Manual patching			
Machine Patching	X			Manual Spray Patching			
Manual Spray patching				Manual Chip Seal			
Manual Chip Seal				Crack Rout and Seal			
Machine Chip Seal							
Fog Seal							
Surface Treatment							
Manual Burn & Seal							
Crack Rout and Seal							

FLEXIBLE PAVEMENT CONDITION EVALUATION FORM (MUNICIPALITIES)

Road No. (Street) Kingston Road **Location From** East of Salem Road **To** East of Lakeridge Road

Section Length 2.5 (KM) **Survey Date** August 24, 2021 **Traffic Direction** B (B: Both Directions, N: North Bound, S: South Bound, E: East Bound, W: West Bound)

Contract No. - **Work Project No.** - **Class** A (F: Freeway, C: Connecting Link, A: Major Arterial, M: Minor Arterial, R: Residential)

Pavement Condition Rating (PCR) 70 **Riding Condition Rating (RCR)** 7.0 **Evaluated by** GBG

Riding Condition Rating (At Posted Speed)

10	8	6	4	2	0
Excellent	Good	Fair	Poor	Very Poor	
Smooth and Pleasant	Comfort-able	Uncomfort-able	Very Rough and Bumpy	Dangerous at Posted Speed	

Pavement Distress Manifestation			Severity of Distress: Slight (1)	Moderate (2)	Severe (3)	Density of Distress % Extent of Occurrence: Intermittent (<20, 1)	Frequent (20-50, 2)	Extensive (>50, 3)
Surface Defects	Ravelling	1	X			X		
	Flushing	2						
	Potholes	3						
	Pavement Edge Breaks	4						
	Manholes and Catchbasins	5	X			X		
Surface Deformation	Rippling and Shoving	6						
	Wheel Track Rutting	7	X			X		
	Distortion	8						
	Utility Trenches	9						
Cracking	Longitudinal	10	X	X				X
	Transverse	11	X					X
	Pavement Edge	12	X			X		
	Map	13	X			X		
	Alligator	14	X	X		X		

Shoulder Distress Manifestation			Severity of Distress: Right Sli (1)	Right Mod (2)	Right Sev (3)	Left Sli (1)	Left Mod (2)	Left Sev (3)	Density of Distress % Extent of Occurrence: Right <20 (1)	Right 20-50 (2)	Right >50 (3)	Left <20 (1)	Left 20-50 (2)	Left >50 (3)
Dominant Type	one	Distress												
Paved Full		Pavement Edge Paved Shoulder Separation												
Paved Partial		Cracking												
Surface Treated		Breakup and Potholes												
Primed		Distortion												
		Pavement Edge Curb Separation												

Curb and Gutter

Maitenance Treatment: Pavement	Extent of Occurrence % <20 (1)	20-50 (2)	>50 (3)	Shoulder	Extent of Occurrence % <20 (1)	20-50 (2)	>50 (3)
Manual Patching	X			Manual patching			
Machine Patching	X			Manual Spray Patching			
Manual Spray patching				Manual Chip Seal			
Manual Chip Seal				Crack Rout and Seal			
Machine Chip Seal							
Fog Seal							
Surface Treatment							
Manual Burn & Seal							
Crack Rout and Seal			X				

Distress Comments (Items not covered above) Roadway has excessive cracking, however, most cracks are slight severity. Many cracks have been routed and sealed. Rural cross section.

Recommendation by Evaluator

FLEXIBLE PAVEMENT CONDITION EVALUATION FORM (MUNICIPALITIES)

Road No. (Street) Dundas Street East **Location From** East of Lakeridge Road **To** West of Fothergill Court

Section Length 1.6 (KM) **Survey Date** August 24, 2021 **Traffic Direction** B (B: Both Directions, N: North Bound, S: South Bound, E: East Bound, W: West Bound)

Contract No. - **Work Project No.** - **Class** A (F: Freeway, C: Connecting Link, A: Major Arterial, M: Minor Arterial, R: Residential)

Pavement Condition Rating (PCR) 85 **Riding Condition Rating (RCR)** 8.5 **Evaluated by** GBG

Riding Condition Rating (At Posted Speed)

10	8	6	4	2	0
Excellent	Good	Fair	Poor	Very Poor	
Smooth and Pleasant	Comfort-able	Uncomfort-able	Very Rough and Bumpy	Dangerous at Posted Speed	

Pavement Distress Manifestation			Severity of Distress: Slight (1)	Moderate (2)	Severe (3)	Density of Distress % Extent of Occurrence: Intermittent (<20, 1)	Frequent (20-50, 2)	Extensive (>50, 3)
Surface Defects	Ravelling	1	X				X	
	Flushing	2						
	Potholes	3						
	Pavement Edge Breaks	4						
	Manholes and Catchbasins	5	X			X		
Surface Deformation	Rippling and Shoving	6						
	Wheel Track Rutting	7						
	Distortion	8						
	Utility Trenches	9						
Cracking	Longitudinal	10	X			X		
	Transverse	11	X			X		
	Pavement Edge	12						
	Map	13						
	Alligator	14						

Distress Comments (Items not covered above)

Recommendation by Evaluator

Shoulder Distress Manifestation: Dominant Type	one	Distress	Severity of Distress: Right Sli (1)	Right Mod (2)	Right Sev (3)	Left Sli (1)	Left Mod (2)	Left Sev (3)	Density of Distress % Extent of Occurrence: Right <20 (1)	Right 20-50 (2)	Right >50 (3)	Left <20 (1)	Left 20-50 (2)	Left >50 (3)
Paved Full		Pavement Edge Paved Shoulder Separation												
Paved Partial		Cracking												
Surface Treated		Breakup and Potholes												
Primed		Distortion												
		Pavement Edge Curb Separation												

Curb and Gutter

Maitenance Treatment: Pavement	Extent of Occurrence %: <20 (1)	20-50 (2)	>50 (3)	Shoulder	Extent of Occurrence %: <20 (1)	20-50 (2)	>50 (3)
Manual Patching				Manual patching			
Machine Patching				Manual Spray Patching			
Manual Spray patching				Manual Chip Seal			
Manual Chip Seal				Crack Rout and Seal			
Machine Chip Seal							
Fog Seal							
Surface Treatment							
Manual Burn & Seal							
Crack Rout and Seal							

FLEXIBLE PAVEMENT CONDITION EVALUATION FORM (MUNICIPALITIES)

Road No. (Street) Dundas Street East **Location From** West of Fothergill Court **To** Jeffrey Street

Section Length 0.5 (KM) **Survey Date** August 24, 2021 **Traffic Direction** B (B: Both Directions, N: North Bound, S: South Bound, E: East Bound, W: West Bound)

Contract No. - **Work Project No.** - **Class** A (F: Freeway, C: Connecting Link, A: Major Arterial, M: Minor Arterial, R: Residential)

Pavement Condition Rating (PCR) 70 **Riding Condition Rating (RCR)** 7.0 **Evaluated by** GBG

Riding Condition Rating (At Posted Speed)

10	8	6	4	2	0
Excellent	Good	Fair	Poor	Very Poor	
Smooth and Pleasant	Comfort-able	Uncomfort-able	Very Rough and Bumpy	Dangerous at Posted Speed	

Pavement Distress Manifestation			Severity of Distress: Slight (1)	Moderate (2)	Severe (3)	Density of Distress % Extent of Occurrence: Intermittent (<20, 1)	Frequent (20-50, 2)	Extensive (>50, 3)
Surface Defects	Ravelling	1	X	X			X	
	Flushing	2	X				X	
	Potholes	3						
	Pavement Edge Breaks	4						
	Manholes and Catchbasins	5		X		X		
Surface Deformation	Rippling and Shoving	6						
	Wheel Track Rutting	7	X				X	
	Distortion	8						
	Utility Trenches	9						
Cracking	Longitudinal	10	X					X
	Transverse	11	X				X	
	Pavement Edge	12						
	Map	13	X				X	
	Alligator	14		X		X		

Distress Comments (Items not covered above)

Recommendation by Evaluator

Shoulder Distress Manifestation: Dominant Type	one	Distress	Severity of Distress: Right Sli (1)	Right Mod (2)	Right Sev (3)	Left Sli (1)	Left Mod (2)	Left Sev (3)	Density of Distress % Extent of Occurrence: Right <20 (1)	Right 20-50 (2)	Right >50 (3)	Left <20 (1)	Left 20-50 (2)	Left >50 (3)
Paved Full		Pavement Edge Paved Shoulder Separation												
Paved Partial		Cracking												
Surface Treated		Breakup and Potholes												
Primed		Distortion												
		Pavement Edge Curb Separation												

Curb and Gutter

Maitenance Treatment: Pavement	Extent of Occurrence % <20 (1)	20-50 (2)	>50 (3)	Shoulder	Extent of Occurrence % <20 (1)	20-50 (2)	>50 (3)
Manual Patching	X			Manual patching			
Machine Patching	X			Manual Spray Patching			
Manual Spray patching				Manual Chip Seal			
Manual Chip Seal				Crack Rout and Seal			
Machine Chip Seal							
Fog Seal							
Surface Treatment							
Manual Burn & Seal							
Crack Rout and Seal			X				

FLEXIBLE PAVEMENT CONDITION EVALUATION FORM (MUNICIPALITIES)

Road No. (Street) Dundas Street East **Location From** Jeffrey Street **To** Annes Street

Section Length 0.8 (KM) **Survey Date** August 24, 2021 **Traffic Direction** B (B: Both Directions, N: North Bound, S: South Bound, E: East Bound, W: West Bound)

Contract No. - **Work Project No.** - **Class** A (F: Freeway, C: Connecting Link, A: Major Arterial, M: Minor Arterial, R: Residential)

Pavement Condition Rating (PCR) 85 **Riding Condition Rating (RCR)** 8.5 **Evaluated by** GBG

Riding Condition Rating (At Posted Speed)

10	8	6	4	2	0
Excellent	Good	Fair	Poor	Very Poor	
Smooth and Pleasant	Comfort-able	Uncomfort-able	Very Rough and Bumpy	Dangerous at Posted Speed	

Pavement Distress Manifestation			Severity of Distress			Density of Distress % Extent of Occurrence		
			Slight	Moderate	Severe	Intermittent	Frequent	Extensive
			1	2	3	< 20	20-50	> 50
						1	2	3
Surface Defects	Ravelling	1						
	Flushing	2						
	Potholes	3						
	Pavement Edge Breaks	4						
	Manholes and Catchbasins	5						
Surface Deformation	Rippling and Shoving	6						
	Wheel Track Rutting	7						
	Distortion	8						
	Utility Trenches	9						
Cracking	Longitudinal	10	X			X		
	Transverse	11	X			X		
	Pavement Edge	12						
	Map	13						
	Alligator	14						

Distress Comments (Items not covered above)

Recommendation by Evaluator

Shoulder Distress Manifestation			Severity of Distress						Density of Distress % Extent of Occurrence					
			Right			Left			Right			Left		
Dominant Type	one	Distress	Sli	Mod	Sev	Sli	Mod	Sev	<20	20-50	>50	<20	20-50	>50
			1	2	3	1	2	3	1	2	3	1	2	3
Paved Full		Pavement Edge Paved Shoulder Separation												
Paved Partial		Cracking												
Surface Treated		Breakup and Potholes												
Primed		Distortion												
		Pavement Edge Curb Separation												

Curb and Gutter

Maitenance Treatment

Pavement	Extent of Occurrence %			Shoulder	Extent of Occurrence %		
	<20	20-50	>50		<20	20-50	>50
	1	2	3		1	2	3
Manual Patching				Manual patching			
Machine Patching				Manual Spray Patching			
Manual Spray patching				Manual Chip Seal			
Manual Chip Seal				Crack Rout and Seal			
Machine Chip Seal							
Fog Seal							
Surface Treatment							
Manual Burn & Seal							
Crack Rout and Seal							

FLEXIBLE PAVEMENT CONDITION EVALUATION FORM (MUNICIPALITIES)

Road No. (Street) Dundas Street East **Location From** Annes Street **To** Brock Street

Section Length 0.8 (KM) **Survey Date** August 24, 2021 **Traffic Direction** B (B: Both Directions, N: North Bound, S: South Bound, E: East Bound, W: West Bound)

Contract No. - **Work Project No.** - **Class** A (F: Freeway, C: Connecting Link, A: Major Arterial, M: Minor Arterial, R: Residential)

Pavement Condition Rating (PCR) 65 **Riding Condition Rating (RCR)** 6.5 **Evaluated by** GBG

Riding Condition Rating (At Posted Speed)

10	8	6	4	2	0
Excellent	Good	Fair	Poor	Very Poor	
Smooth and Pleasant	Comfort-able	Uncomfort-able	Very Rough and Bumpy	Dangerous at Posted Speed	

Pavement Distress Manifestation			Severity of Distress: Slight (1)	Moderate (2)	Severe (3)	Density of Distress % Extent of Occurrence: Intermittent (<20) (1)	Frequent (20-50) (2)	Extensive (>50) (3)
Surface Defects	Ravelling	1		X			X	
	Flushing	2	X			X		
	Potholes	3		X		X		
	Pavement Edge Breaks	4		X		X		
	Manholes and Catchbasins	5		X	X		X	
Surface Deformation	Rippling and Shoving	6						
	Wheel Track Rutting	7	X					X
	Distortion	8						
	Utility Trenches	9						
Cracking	Longitudinal	10	X	X			X	
	Transverse	11	X	X			X	
	Pavement Edge	12						
	Map	13	X			X		
	Alligator	14		X	X	X		

Distress Comments (Items not covered above) Catchbasins in poor condition.

Recommendation by Evaluator

Shoulder Distress Manifestation: Dominant Type	Done	Distress	Severity of Distress: Right Sli (1)	Right Mod (2)	Right Sev (3)	Left Sli (1)	Left Mod (2)	Left Sev (3)	Density of Distress % Extent of Occurrence: Right <20 (1)	Right 20-50 (2)	Right >50 (3)	Left <20 (1)	Left 20-50 (2)	Left >50 (3)
Paved Full		Pavement Edge Paved Shoulder Separation												
Paved Partial		Cracking												
Surface Treated		Breakup and Potholes												
Primed		Distortion												
		Pavement Edge Curb Separation												

Curb and Gutter

Maitenance Treatment: Pavement	Extent of Occurrence % <20 (1)	20-50 (2)	>50 (3)	Shoulder	Extent of Occurrence % <20 (1)	20-50 (2)	>50 (3)
Manual Patching	X			Manual patching			
Machine Patching				Manual Spray Patching			
Manual Spray patching				Manual Chip Seal			
Manual Chip Seal				Crack Rout and Seal			
Machine Chip Seal							
Fog Seal							
Surface Treatment							
Manual Burn & Seal							
Crack Rout and Seal		X					

FLEXIBLE PAVEMENT CONDITION EVALUATION FORM (MUNICIPALITIES)

Road No. (Street) Dundas Street East **Location From** Brock Street **To** Hickory Street

Section Length 0.4 (KM) **Survey Date** August 24, 2021 **Traffic Direction** B (B: Both Directions, N: North Bound, S: South Bound, E: East Bound, W: West Bound)

Contract No. - **Work Project No.** - **Class** A (F: Freeway, C: Connecting Link, A: Major Arterial, M: Minor Arterial, R: Residential)

Pavement Condition Rating (PCR) 85 **Riding Condition Rating (RCR)** 8.5 **Evaluated by** GBG

Riding Condition Rating (At Posted Speed)

10	8	6	4	2	0
Excellent	Good	Fair	Poor	Very Poor	
Smooth and Pleasant	Comfort-able	Uncomfort-able	Very Rough and Bumpy	Dangerous at Posted Speed	

Pavement Distress Manifestation			Severity of Distress: Slight (1)	Moderate (2)	Severe (3)	Density of Distress % Extent of Occurrence: Intermittent (<20, 1)	Frequent (20-50, 2)	Extensive (>50, 3)
Surface Defects	Ravelling	1						
	Flushing	2	X			X		
	Potholes	3						
	Pavement Edge Breaks	4						
	Manholes and Catchbasins	5						
Surface Deformation	Rippling and Shoving	6						
	Wheel Track Rutting	7						
	Distortion	8						
	Utility Trenches	9						
Cracking	Longitudinal	10						
	Transverse	11	X			X		
	Pavement Edge	12						
	Map	13						
	Alligator	14						

Distress Comments (Items not covered above)

Recommendation by Evaluator

Shoulder Distress Manifestation			Severity of Distress: Right Sli (1)	Right Mod (2)	Right Sev (3)	Left Sli (1)	Left Mod (2)	Left Sev (3)	Density of Distress % Extent of Occurrence: Right <20 (1)	Right 20-50 (2)	Right >50 (3)	Left <20 (1)	Left 20-50 (2)	Left >50 (3)
Dominant Type	one	Distress												
Paved Full		Pavement Edge												
		Paved Shoulder Separation												
Paved Partial		Cracking												
		Breakup and Potholes												
Surface Treated														
		Distortion												
Primed		Pavement Edge Curb Separation												

Curb and Gutter

Maitenance Treatment								
Pavement	Extent of Occurrence %: <20 (1)	20-50 (2)	>50 (3)	Shoulder	Extent of Occurrence %: <20 (1)	20-50 (2)	>50 (3)
Manual Patching				Manual patching			
Machine Patching				Manual Spray Patching			
Manual Spray patching				Manual Chip Seal			
Manual Chip Seal				Crack Rout and Seal			
Machine Chip Seal							
Fog Seal							
Surface Treatment							
Manual Burn & Seal							
Crack Rout and Seal							

FLEXIBLE PAVEMENT CONDITION EVALUATION FORM (MUNICIPALITIES)

Road No. (Street) Dundas Street East **Location From** Hickory Street **To** Garrard Road

Section Length 2.9 (KM) **Survey Date** August 24, 2021 **Traffic Direction** B (B: Both Directions, N: North Bound, S: South Bound, E: East Bound, W: West Bound)

Contract No. - **Work Project No.** - **Class** A (F: Freeway, C: Connecting Link, A: Major Arterial, M: Minor Arterial, R: Residential)

Pavement Condition Rating (PCR) 70 **Riding Condition Rating (RCR)** 7.0 **Evaluated by** GBG

Riding Condition Rating (At Posted Speed)

10	8	6	4	2	0
Excellent	Good	Fair	Poor	Very Poor	
Smooth and Pleasant	Comfort-able	Uncomfort-able	Very Rough and Bumpy	Dangerous at Posted Speed	

Pavement Distress Manifestation			Severity of Distress: Slight (1)	Moderate (2)	Severe (3)	Density of Distress % Extent of Occurrence: Intermittent (<20) (1)	Frequent (20-50) (2)	Extensive (>50) (3)
Surface Defects	Ravelling	1	X			X		
	Flushing	2	X			X		
	Potholes	3						
	Pavement Edge Breaks	4						
	Manholes and Catchbasins	5						
Surface Deformation	Rippling and Shoving	6			X	X		
	Wheel Track Rutting	7	X					X
	Distortion	8						
	Utility Trenches	9	X			X		
Cracking	Longitudinal	10	X	X				X
	Transverse	11	X	X				X
	Pavement Edge	12						
	Map	13	X					X
	Alligator	14		X		X		

Shoulder Distress Manifestation			Severity of Distress: Right Sli (1)	Right Mod (2)	Right Sev (3)	Left Sli (1)	Left Mod (2)	Left Sev (3)	Density of Distress % Extent of Occurrence: Right <20 (1)	Right 20-50 (2)	Right >50 (3)	Left <20 (1)	Left 20-50 (2)	Left >50 (3)
Dominant Type	one	Distress												
Paved Full		Pavement Edge Paved Shoulder Separation												
Paved Partial		Cracking												
Surface Treated		Breakup and Potholes												
Primed		Distortion												
		Pavement Edge Curb Separation												

Curb and Gutter

Maitenance Treatment: Pavement	Extent of Occurrence % <20 (1)	20-50 (2)	>50 (3)	Shoulder	Extent of Occurrence % <20 (1)	20-50 (2)	>50 (3)
Manual Patching	X			Manual patching			
Machine Patching		X		Manual Spray Patching			
Manual Spray patching				Manual Chip Seal			
Manual Chip Seal				Crack Rout and Seal			
Machine Chip Seal							
Fog Seal							
Surface Treatment							
Manual Burn & Seal							
Crack Rout and Seal		X					

Distress Comments (Items not covered above) Severe rippling at Thickson Road intersection. Small section west of Glen Hill Drive in slightly better condition.

Recommendation by Evaluator

FLEXIBLE PAVEMENT CONDITION EVALUATION FORM (MUNICIPALITIES)

Road No. (Street) Dundas Street East / King Street West (EB) **Location From** Garrard Road **To** Simcoe Street

Section Length 3.3 (KM) **Survey Date** August 24, 2021 **Traffic Direction** B (B: Both Directions, N: North Bound, S: South Bound, E: East Bound, W: West Bound)

Contract No. - **Work Project No.** - **Class** A (F: Freeway, C: Connecting Link, A: Major Arterial, M: Minor Arterial, R: Residential)

Pavement Condition Rating (PCR) 55 **Riding Condition Rating (RCR)** 5.5 **Evaluated by** GBG

Riding Condition Rating (At Posted Speed)

10	8	6	4	2	0
Excellent	Good	Fair	Poor	Very Poor	
Smooth and Pleasant	Comfort-able	Uncomfort-able	Very Rough and Bumpy	Dangerous at Posted Speed	

Pavement Distress Manifestation			Severity of Distress: Slight (1)	Moderate (2)	Severe (3)	Density of Distress % Extent of Occurrence: Intermittent (<20) (1)	Frequent (20-50) (2)	Extensive (>50) (3)
Surface Defects	Ravelling	1	X			X		
	Flushing	2	X			X		
	Potholes	3						
	Pavement Edge Breaks	4		X		X		
	Manholes and Catchbasins	5			X		X	
Surface Deformation	Rippling and Shoving	6						
	Wheel Track Rutting	7	X	X				X
	Distortion	8						
	Utility Trenches	9	X			X		
Cracking	Longitudinal	10		X	X			X
	Transverse	11		X	X			X
	Pavement Edge	12						
	Map	13		X				X
	Alligator	14		X	X		X	

Distress Comments (Items not covered above)

Recommendation by Evaluator

Shoulder Distress Manifestation			Severity of Distress: Right Sli (1)	Right Mod (2)	Right Sev (3)	Left Sli (1)	Left Mod (2)	Left Sev (3)	Density of Distress % Extent of Occurrence: Right <20 (1)	Right 20-50 (2)	Right >50 (3)	Left <20 (1)	Left 20-50 (2)	Left >50 (3)
Dominant Type	one	Distress												
Paved Full		Pavement Edge Paved Shoulder Separation												
Paved Partial		Cracking												
Surface Treated		Breakup and Potholes												
Primed		Distortion												
		Pavement Edge Curb Separation												

Curb and Gutter

Maitenance Treatment: Pavement	Extent of Occurrence % <20 (1)	20-50 (2)	>50 (3)	Shoulder	Extent of Occurrence % <20 (1)	20-50 (2)	>50 (3)
Manual Patching	X			Manual patching			
Machine Patching		X		Manual Spray Patching			
Manual Spray patching				Manual Chip Seal			
Manual Chip Seal				Crack Rout and Seal			
Machine Chip Seal							
Fog Seal							
Surface Treatment							
Manual Burn & Seal							
Crack Rout and Seal		X					

FLEXIBLE PAVEMENT CONDITION EVALUATION FORM (MUNICIPALITIES)

Road No. (Street) Bond Street West / Dundas Street East (WB) **Location From** Simcoe Street **To** Garrard Street

Section Length 3.3 (KM) **Survey Date** August 24, 2021 **Traffic Direction** B (B: Both Directions, N: North Bound, S: South Bound, E: East Bound, W: West Bound)

Contract No. - **Work Project No.** - **Class** A (F: Freeway, C: Connecting Link, A: Major Arterial, M: Minor Arterial, R: Residential)

Pavement Condition Rating (PCR) 55 **Riding Condition Rating (RCR)** 5.5 **Evaluated by** GBG

Riding Condition Rating (At Posted Speed)

10	8	6	4	2	0
Excellent	Good	Fair	Poor	Very Poor	
Smooth and Pleasant	Comfort-able	Uncomfort-able	Very Rough and Bumpy	Dangerous at Posted Speed	

Pavement Distress Manifestation			Severity of Distress: Slight (1)	Moderate (2)	Severe (3)	Density of Distress % Extent of Occurrence: Intermittent (<20) (1)	Frequent (20-50) (2)	Extensive (>50) (3)
Surface Defects	Ravelling	1	X			X		
	Flushing	2	X			X		
	Potholes	3						
	Pavement Edge Breaks	4		X		X		
	Manholes and Catchbasins	5			X		X	
Surface Deformation	Rippling and Shoving	6						
	Wheel Track Rutting	7	X	X				X
	Distortion	8						
	Utility Trenches	9	X			X		
Cracking	Longitudinal	10		X	X			X
	Transverse	11		X	X			X
	Pavement Edge	12						
	Map	13		X				X
	Alligator	14		X	X		X	

Distress Comments (Items not covered above)

Recommendation by Evaluator

Shoulder Distress Manifestation: Dominant Type	one	Distress	Severity of Distress: Right Sli (1)	Right Mod (2)	Right Sev (3)	Left Sli (1)	Left Mod (2)	Left Sev (3)	Density of Distress % Extent of Occurrence: Right <20 (1)	Right 20-50 (2)	Right >50 (3)	Left <20 (1)	Left 20-50 (2)	Left >50 (3)
Paved Full		Pavement Edge Paved Shoulder Separation												
Paved Partial		Cracking												
Surface Treated		Breakup and Potholes												
		Distortion												
Primed		Pavement Edge Curb Separation												

Curb and Gutter

Maitenance Treatment

Pavement	Extent of Occurrence %: <20 (1)	20-50 (2)	>50 (3)	Shoulder	Extent of Occurrence %: <20 (1)	20-50 (2)	>50 (3)
Manual Patching	X			Manual patching			
Machine Patching		X		Manual Spray Patching			
Manual Spray patching				Manual Chip Seal			
Manual Chip Seal				Crack Rout and Seal			
Machine Chip Seal							
Fog Seal							
Surface Treatment							
Manual Burn & Seal							
Crack Rout and Seal		X					

APPENDIX B

ESALs and AASHTO

Table B1
EQUIVALENT SINGLE AXLE LOAD CALCULATION

Durham-Scarborough Bus Rapid Transit (DS BRT)
Ellesmere Road
Section 1 - McCowan Road to Markham Road

1) Traffic Analysis

Traffic Data Year		2019		2031	2041
Design Year		**2031**			
Traffic Analysis Period			12		10
Average Annual Daily Traffic (AADT)		32,288		33,588	34,488
Average Rate of Increase in Traffic (%)			0.33		0.26
Truck Fraction of Total Traffic (%)		4.84		4.84	4.84
Average Rate of Increase in Truck Fraction (%)			0.00		0.00
Number of Lanes in One Direction		2		2	2
Directional Factor		0.5		0.5	0.5
Lane Distribution Factor		0.8		0.8	0.8
Daily Truck Volume		**650**		**650**	**667**

2) Daily ESALs Analysis

Road Classification		***Urban Minor Arterial***		
Traffic Analysis Base Year		2031	2031	2041
Breakdown of Truck Proportions (%)	Class 1	65		
	Class 2	5		
	Class 3	20		
	Class 4	10		
Daily Truck Volumes for 4 Classes	Class 1	422	422	434
	Class 2	32	32	33
	Class 3	130	130	133
	Class 4	65	65	67
Truck Factors for 4 Classes of Truck	Class 1	0.5		
	Class 2	2.3		
	Class 3	1.6		
	Class 4	5.5		
Weighted Average Truck Factor			**1.310**	
Daily ESALs per Truck Class	Class 1	211	211	217
	Class 2	75	75	77
	Class 3	208	208	214
	Class 4	357	357	367
Total Daily ESALs in Design Lane		**851**	**851**	**874**

3) Total ESALs for Base Year

Base Year	2031	2031	2041
Number of Days of Truck Traffic	365	365	365
Total ESALs for Base Year	**310,777**	**310,606**	**319,022**

4) Cumulative ESALs for the Design Period

Design Period (Years)	**19**	
Span of Design Periods	2031 to 2031	2031 to 2050
Average Rate of Increase in Truck Volume (%)		0.27
Years of Design Periods	0	19
Growth Factor	0.00	19.46
ESALs for the Design Periods	0	6,044,000
Cumulative ESALs for the Design Period	**6,044,283**	

Note: The ESAL calculations are baesd on the guidelines "Procedures for Estimating Traffic Loads for Pavement Design" by Jerry Hajek, 1995, and on MTO's "Adaptation and Verification of AASHTO Pavement Design Guide for Ontario Conditions", March 19, 2008.

Designed by: GBG
Checked by: _____

Table B2
EQUIVALENT SINGLE AXLE LOAD CALCULATION

Durham-Scarborough Bus Rapid Transit (DS BRT)
Ellesmere Road
Section 2 - Markham Road to Military Trail

1) Traffic Analysis

Traffic Data Year		2019		2031	2041
Design Year		**2031**			
Traffic Analysis Period			12	10	
Average Annual Daily Traffic (AADT)		28,669		30,369	31,569
Average Rate of Increase in Traffic (%)			0.48	0.39	
Truck Fraction of Total Traffic (%)		4.82		4.83	4.82
Average Rate of Increase in Truck Fraction (%)			0.01	-0.01	
Number of Lanes in One Direction		2		2	2
Directional Factor		0.5		0.5	0.5
Lane Distribution Factor		0.8		0.8	0.8
Daily Truck Volume		**586**		**586**	**609**

2) Daily ESALs Analysis

Road Classification		***Urban Minor Arterial***		
Traffic Analysis Base Year		2031	2031	2041
Breakdown of Truck Proportions (%)	Class 1	65		
	Class 2	5		
	Class 3	20		
	Class 4	10		
Daily Truck Volumes for 4 Classes	Class 1	381	381	396
	Class 2	29	29	30
	Class 3	117	117	122
	Class 4	59	59	61
Truck Factors for 4 Classes of Truck	Class 1	0.5		
	Class 2	2.3		
	Class 3	1.6		
	Class 4	5.5		
Weighted Average Truck Factor			**1.310**	
Daily ESALs per Truck Class	Class 1	190	191	198
	Class 2	67	67	70
	Class 3	187	188	195
	Class 4	322	323	335
Total Daily ESALs in Design Lane		**767**	**768**	**798**

3) Total ESALs for Base Year

Base Year	2031	2031	2041
Number of Days of Truck Traffic	365	365	365
Total ESALs for Base Year	**279,995**	**280,387**	**291,098**

4) Cumulative ESALs for the Design Period

Design Period (Years)	**19**	
Span of Design Periods	2031 to 2031	2031 to 2050
Average Rate of Increase in Truck Volume (%)		0.38
Years of Design Periods	0	19
Growth Factor	0.00	19.68
ESALs for the Design Periods	0	5,518,000
Cumulative ESALs for the Design Period	**5,517,684**	

Note: The ESAL calculations are baesd on the guidelines "Procedures for Estimating Traffic Loads for Pavement Design" by Jerry Hajek, 1995, and on MTO's "Adaptation and Verification of AASHTO Pavement Design Guide for Ontario Conditions", March 19, 2008.

Designed by: GBG
Checked by: _____

Table B3
EQUIVALENT SINGLE AXLE LOAD CALCULATION

Durham-Scarborough Bus Rapid Transit (DS BRT)
Ellesmere Road
Section 3 - Military Trail to Morningside Avenue

1) Traffic Analysis

Traffic Data Year		2019		2031	2041
Design Year		**2031**			
Traffic Analysis Period			12		10
Average Annual Daily Traffic (AADT)		21,815		23,515	24,715
Average Rate of Increase in Traffic (%)			0.63		0.50
Truck Fraction of Total Traffic (%)		4.82		4.82	4.83
Average Rate of Increase in Truck Fraction (%)			0.00		0.01
Number of Lanes in One Direction		2		2	2
Directional Factor		0.5		0.5	0.5
Lane Distribution Factor		0.8		0.8	0.8
Daily Truck Volume		**454**		**454**	**477**

2) Daily ESALs Analysis

Road Classification		***Urban Minor Arterial***		
Traffic Analysis Base Year		2031	2031	2041
Breakdown of Truck Proportions (%)	Class 1	65		
	Class 2	5		
	Class 3	20		
	Class 4	10		
Daily Truck Volumes for 4 Classes	Class 1	295	295	310
	Class 2	23	23	24
	Class 3	91	91	95
	Class 4	45	45	48
Truck Factors for 4 Classes of Truck	Class 1	0.5		
	Class 2	2.3		
	Class 3	1.6		
	Class 4	5.5		
Weighted Average Truck Factor			**1.310**	
Daily ESALs per Truck Class	Class 1	147	147	155
	Class 2	52	52	55
	Class 3	145	145	153
	Class 4	249	249	262
Total Daily ESALs in Design Lane		**594**	**594**	**625**

3) Total ESALs for Base Year

Base Year	2031	2031	2041
Number of Days of Truck Traffic	365	365	365
Total ESALs for Base Year	**216,885**	**216,889**	**228,173**

4) Cumulative ESALs for the Design Period

Design Period (Years)	**19**	
Span of Design Periods	2031 to 2031	2031 to 2050
Average Rate of Increase in Truck Volume (%)		0.51
Years of Design Periods	0	19
Growth Factor	0.00	19.88
ESALs for the Design Periods	0	4,311,000
Cumulative ESALs for the Design Period	**4,311,280**	

Note: The ESAL calculations are baesd on the guidelines "Procedures for Estimating Traffic Loads for Pavement Design" by Jerry Hajek, 1995, and on MTO's "Adaptation and Verification of AASHTO Pavement Design Guide for Ontario Conditions", March 19, 2008.

Designed by: GBG
Checked by: _____

Table B4
EQUIVALENT SINGLE AXLE LOAD CALCULATION

Durham-Scarborough Bus Rapid Transit (DS BRT)
Ellesmere Road and short section o Kingston Road
Section 4 - Morningside Avenue to Kingston Road and Kingston Road from Ellesmere Road to Highway 401

1) Traffic Analysis

Traffic Data Year		2019	2031	2041
Design Year		**2031**		
Traffic Analysis Period			12	10
Average Annual Daily Traffic (AADT)		14,174	16,274	17,774
Average Rate of Increase in Traffic (%)			1.16	0.89
Truck Fraction of Total Traffic (%)		4.83	4.83	4.83
Average Rate of Increase in Truck Fraction (%)			0.01	-0.01
Number of Lanes in One Direction		2	2	2
Directional Factor		0.5	0.5	0.5
Lane Distribution Factor		0.9	0.8	0.8
Daily Truck Volume		**353**	**314**	**343**

2) Daily ESALs Analysis

Road Classification			***Urban Minor Arterial***	
Traffic Analysis Base Year		2031	2031	2041
Breakdown of Truck Proportions (%)	Class 1	65		
	Class 2	5		
	Class 3	20		
	Class 4	10		
Daily Truck Volumes for 4 Classes	Class 1	230	204	223
	Class 2	18	16	17
	Class 3	71	63	69
	Class 4	35	31	34
Truck Factors for 4 Classes of Truck	Class 1	0.5		
	Class 2	2.3		
	Class 3	1.6		
	Class 4	5.5		
Weighted Average Truck Factor			**1.310**	
Daily ESALs per Truck Class	Class 1	115	102	112
	Class 2	41	36	39
	Class 3	113	101	110
	Class 4	194	173	189
Total Daily ESALs in Design Lane		**463**	**412**	**450**

3) Total ESALs for Base Year

	2031	2031	2041
Base Year			
Number of Days of Truck Traffic	365	365	365
Total ESALs for Base Year	**168,980**	**150,330**	**164,101**

4) Cumulative ESALs for the Design Period

Design Period (Years)	**19**	
Span of Design Periods	2031 to 2031	2031 to 2050
Average Rate of Increase in Truck Volume (%)		0.88
Years of Design Periods	0	19
Growth Factor	0.00	20.59
ESALs for the Design Periods	0	3,096,000
Cumulative ESALs for the Design Period	**3,095,768**	

Note: The ESAL calculations are baesd on the guidelines "Procedures for Estimating Traffic Loads for Pavement Design" by Jerry Hajek, 1995, and on MTO's "Adaptation and Verification of AASHTO Pavement Design Guide for Ontario Conditions", March 19, 2008.

Designed by: GBG
Checked by: _____

Table B5
EQUIVALENT SINGLE AXLE LOAD CALCULATION

Durham-Scarborough Bus Rapid Transit (DS BRT)
Kingston Road
Section 5 - Highway 401 to the CN Rail

1) Traffic Analysis

Traffic Data Year		2019		2031	2041
Design Year		**2031**			
Traffic Analysis Period			12		10
Average Annual Daily Traffic (AADT)		41,445		43,445	44,945
Average Rate of Increase in Traffic (%)			0.39		0.34
Truck Fraction of Total Traffic (%)		5.98		5.99	6.00
Average Rate of Increase in Truck Fraction (%)			0.01		0.02
Number of Lanes in One Direction		2		2	2
Directional Factor		0.5		0.5	0.5
Lane Distribution Factor		0.8		0.8	0.8
Daily Truck Volume		**1,039**		**1,040**	**1,078**

2) Daily ESALs Analysis

Road Classification		***Urban Minor Arterial***		
Traffic Analysis Base Year		2031	2031	2041
Breakdown of Truck Proportions (%)	Class 1	65		
	Class 2	5		
	Class 3	20		
	Class 4	10		
Daily Truck Volumes for 4 Classes	Class 1	675	676	701
	Class 2	52	52	54
	Class 3	208	208	216
	Class 4	104	104	108
Truck Factors for 4 Classes of Truck	Class 1	0.5		
	Class 2	2.3		
	Class 3	1.6		
	Class 4	5.5		
Weighted Average Truck Factor			**1.310**	
Daily ESALs per Truck Class	Class 1	338	338	350
	Class 2	119	120	124
	Class 3	332	333	345
	Class 4	571	572	593
Total Daily ESALs in Design Lane		**1,361**	**1,363**	**1,412**

3) Total ESALs for Base Year

Base Year	2031	2031	2041
Number of Days of Truck Traffic	365	365	365
Total ESALs for Base Year	**496,613**	**497,467**	**515,446**

4) Cumulative ESALs for the Design Period

Design Period (Years)	**19**	
Span of Design Periods	2031 to 2031	2031 to 2050
Average Rate of Increase in Truck Volume (%)		0.36
Years of Design Periods	0	19
Growth Factor	0.00	19.59
ESALs for the Design Periods	0	9,747,000
Cumulative ESALs for the Design Period	**9,746,767**	

Note: The ESAL calculations are baesd on the guidelines "Procedures for Estimating Traffic Loads for Pavement Design" by Jerry Hajek, 1995, and on MTO's "Adaptation and Verification of AASHTO Pavement Design Guide for Ontario Conditions", March 19, 2008.

Table B6
EQUIVALENT SINGLE AXLE LOAD CALCULATION

Durham-Scarborough Bus Rapid Transit (DS BRT)
Kingston Road
Section 6 - The CN Rail to Liverpool Road

1) Traffic Analysis

Traffic Data Year		2019	2031		2041
Design Year		**2031**			
Traffic Analysis Period			12	10	
Average Annual Daily Traffic (AADT)		32,651	36,051		37,851
Average Rate of Increase in Traffic (%)			0.83	0.49	
Truck Fraction of Total Traffic (%)		2.24	2.25		2.26
Average Rate of Increase in Truck Fraction (%)			0.05	0.04	
Number of Lanes in One Direction		2	2		2
Directional Factor		0.5	0.5		0.5
Lane Distribution Factor		0.8	0.8		0.8
Daily Truck Volume		**322**	**324**		**342**

2) Daily ESALs Analysis

Road Classification			***Urban Minor Arterial***	
Traffic Analysis Base Year		2031	2031	2041
Breakdown of Truck Proportions (%)	Class 1	65		
	Class 2	5		
	Class 3	20		
	Class 4	10		
Daily Truck Volumes for 4 Classes	Class 1	210	211	222
	Class 2	16	16	17
	Class 3	64	65	68
	Class 4	32	32	34
Truck Factors for 4 Classes of Truck	Class 1	0.5		
	Class 2	2.3		
	Class 3	1.6		
	Class 4	5.5		
Weighted Average Truck Factor			**1.310**	
Daily ESALs per Truck Class	Class 1	105	105	111
	Class 2	37	37	39
	Class 3	103	104	109
	Class 4	177	178	188
Total Daily ESALs in Design Lane		**422**	**425**	**448**

3) Total ESALs for Base Year

Base Year	2031	2031	2041
Number of Days of Truck Traffic	365	365	365
Total ESALs for Base Year	**154,159**	**155,112**	**163,527**

4) Cumulative ESALs for the Design Period

Design Period (Years)	**19**	
Span of Design Periods	2031 to 2031	2031 to 2050
Average Rate of Increase in Truck Volume (%)		0.53
Years of Design Periods	0	19
Growth Factor	0.00	19.86
ESALs for the Design Periods	0	3,080,000
Cumulative ESALs for the Design Period	**3,080,330**	

Note: The ESAL calculations are baesd on the guidelines "Procedures for Estimating Traffic Loads for Pavement Design" by Jerry Hajek, 1995, and on MTO's "Adaptation and Verification of AASHTO Pavement Design Guide for Ontario Conditions", March 19, 2008.

Designed by: GBG
Checked by: _____

Table B7
EQUIVALENT SINGLE AXLE LOAD CALCULATION

Durham-Scarborough Bus Rapid Transit (DS BRT)
Kingston Road
Section 7 - Liverpool Road to Glengrove Road

1) Traffic Analysis

Traffic Data Year		2018		2031	2041
Design Year		**2031**			
Traffic Analysis Period			13	10	
Average Annual Daily Traffic (AADT)		33,230		35,530	36,830
Average Rate of Increase in Traffic (%)			0.52	0.36	
Truck Fraction of Total Traffic (%)		3.61		3.61	3.61
Average Rate of Increase in Truck Fraction (%)			-0.01	0.00	
Number of Lanes in One Direction		2		2	2
Directional Factor		0.5		0.5	0.5
Lane Distribution Factor		0.8		0.8	0.8
Daily Truck Volume		**513**		**513**	**532**

2) Daily ESALs Analysis

Road Classification		***Urban Minor Arterial***		
Traffic Analysis Base Year		2031	2031	2041
Breakdown of Truck Proportions (%)	Class 1	65		
	Class 2	5		
	Class 3	20		
	Class 4	10		
Daily Truck Volumes for 4 Classes	Class 1	334	333	346
	Class 2	26	26	27
	Class 3	103	103	106
	Class 4	51	51	53
Truck Factors for 4 Classes of Truck	Class 1	0.5		
	Class 2	2.3		
	Class 3	1.6		
	Class 4	5.5		
Weighted Average Truck Factor			**1.310**	
Daily ESALs per Truck Class	Class 1	167	167	173
	Class 2	59	59	61
	Class 3	164	164	170
	Class 4	282	282	292
Total Daily ESALs in Design Lane		**672**	**672**	**696**

3) Total ESALs for Base Year

Base Year	2031	2031	2041
Number of Days of Truck Traffic	365	365	365
Total ESALs for Base Year	**245,398**	**245,195**	**254,185**

4) Cumulative ESALs for the Design Period

Design Period (Years)	**19**	
Span of Design Periods	2031 to 2031	2031 to 2050
Average Rate of Increase in Truck Volume (%)		0.36
Years of Design Periods	0	19
Growth Factor	0.00	19.63
ESALs for the Design Periods	0	4,813,000
Cumulative ESALs for the Design Period	**4,812,777**	

Note: The ESAL calculations are baesd on the guidelines "Procedures for Estimating Traffic Loads for Pavement Design" by Jerry Hajek, 1995, and on MTO's "Adaptation and Verification of AASHTO Pavement Design Guide for Ontario Conditions", March 19, 2008.

Designed by: GBG
Checked by: _____

Table B8
EQUIVALENT SINGLE AXLE LOAD CALCULATION

Durham-Scarborough Bus Rapid Transit (DS BRT)
Kingston Road
Section 8 - Glengrove Road to Royal Road

1) Traffic Analysis

Traffic Data Year		2018		2031	2041
Design Year		**2031**			
Traffic Analysis Period			13	10	
Average Annual Daily Traffic (AADT)		33,230		35,530	36,830
Average Rate of Increase in Traffic (%)			0.52	0.36	
Truck Fraction of Total Traffic (%)		3.61		3.61	3.61
Average Rate of Increase in Truck Fraction (%)			-0.01	0.00	
Number of Lanes in One Direction		2		2	2
Directional Factor		0.5		0.5	0.5
Lane Distribution Factor		0.8		0.8	0.8
Daily Truck Volume		**513**		**513**	**532**

2) Daily ESALs Analysis

Road Classification		***Urban Minor Arterial***		
Traffic Analysis Base Year		2031	2031	2041
Breakdown of Truck Proportions (%)	Class 1	65		
	Class 2	5		
	Class 3	20		
	Class 4	10		
Daily Truck Volumes for 4 Classes	Class 1	334	333	346
	Class 2	26	26	27
	Class 3	103	103	106
	Class 4	51	51	53
Truck Factors for 4 Classes of Truck	Class 1	0.5		
	Class 2	2.3		
	Class 3	1.6		
	Class 4	5.5		
Weighted Average Truck Factor			**1.310**	
Daily ESALs per Truck Class	Class 1	167	167	173
	Class 2	59	59	61
	Class 3	164	164	170
	Class 4	282	282	292
Total Daily ESALs in Design Lane		**672**	**672**	**696**

3) Total ESALs for Base Year

Base Year	2031	2031	2041
Number of Days of Truck Traffic	365	365	365
Total ESALs for Base Year	**245,398**	**245,195**	**254,185**

4) Cumulative ESALs for the Design Period

Design Period (Years)	**19**	
Span of Design Periods	2031 to 2031	2031 to 2050
Average Rate of Increase in Truck Volume (%)		0.36
Years of Design Periods	0	19
Growth Factor	0.00	19.63
ESALs for the Design Periods	0	4,813,000
Cumulative ESALs for the Design Period	**4,812,777**	

Note: The ESAL calculations are baesd on the guidelines "Procedures for Estimating Traffic Loads for Pavement Design" by Jerry Hajek, 1995, and on MTO's "Adaptation and Verification of AASHTO Pavement Design Guide for Ontario Conditions", March 19, 2008.

Table B9
EQUIVALENT SINGLE AXLE LOAD CALCULATION

Durham-Scarborough Bus Rapid Transit (DS BRT)
Kingston Road
Section 9 - Royal Road to Southview Drive

1) Traffic Analysis

Traffic Data Year		2018		2031	2041
Design Year		**2031**			
Traffic Analysis Period			13	10	
Average Annual Daily Traffic (AADT)		32,806		35,406	36,806
Average Rate of Increase in Traffic (%)			0.59	0.39	
Truck Fraction of Total Traffic (%)		2.90		2.90	2.90
Average Rate of Increase in Truck Fraction (%)			0.00	-0.01	
Number of Lanes in One Direction		2		2	2
Directional Factor		0.5		0.5	0.5
Lane Distribution Factor		0.8		0.8	0.8
Daily Truck Volume		**411**		**411**	**427**

2) Daily ESALs Analysis

Road Classification		***Urban Minor Arterial***		
Traffic Analysis Base Year		2031	2031	2041
Breakdown of Truck Proportions (%)	Class 1	65		
	Class 2	5		
	Class 3	20		
	Class 4	10		
Daily Truck Volumes for 4 Classes	Class 1	267	267	277
	Class 2	21	21	21
	Class 3	82	82	85
	Class 4	41	41	43
Truck Factors for 4 Classes of Truck	Class 1	0.5		
	Class 2	2.3		
	Class 3	1.6		
	Class 4	5.5		
Weighted Average Truck Factor			**1.310**	
Daily ESALs per Truck Class	Class 1	133	134	139
	Class 2	47	47	49
	Class 3	131	131	137
	Class 4	226	226	235
Total Daily ESALs in Design Lane		**538**	**538**	**559**

3) Total ESALs for Base Year

Base Year	2031	2031	2041
Number of Days of Truck Traffic	365	365	365
Total ESALs for Base Year	**196,304**	**196,424**	**204,074**

4) Cumulative ESALs for the Design Period

Design Period (Years)	**19**	
Span of Design Periods	2031 to 2031	2031 to 2050
Average Rate of Increase in Truck Volume (%)		0.38
Years of Design Periods	0	19
Growth Factor	0.00	19.68
ESALs for the Design Periods	0	3,865,000
Cumulative ESALs for the Design Period	**3,865,483**	

Note: The ESAL calculations are baesd on the guidelines "Procedures for Estimating Traffic Loads for Pavement Design" by Jerry Hajek, 1995, and on MTO's "Adaptation and Verification of AASHTO Pavement Design Guide for Ontario Conditions", March 19, 2008.

Table B10
EQUIVALENT SINGLE AXLE LOAD CALCULATION

Durham-Scarborough Bus Rapid Transit (DS BRT)
Kingston Road
Section 10 - Southview Drive to Rotherglen Road South

1) Traffic Analysis

Traffic Data Year		2018	2031	2041
Design Year		**2031**		
Traffic Analysis Period		13	10	
Average Annual Daily Traffic (AADT)		44,338	46,238	47,238
Average Rate of Increase in Traffic (%)		0.32	0.21	
Truck Fraction of Total Traffic (%)		3.20	3.21	3.21
Average Rate of Increase in Truck Fraction (%)		0.01	0.00	
Number of Lanes in One Direction		2	2	2
Directional Factor		0.5	0.5	0.5
Lane Distribution Factor		0.8	0.8	0.8
Daily Truck Volume		**593**	**593**	**606**

2) Daily ESALs Analysis

Road Classification			***Urban Minor Arterial***	
Traffic Analysis Base Year		2031	2031	2041
Breakdown of Truck Proportions (%)	Class 1	65		
	Class 2	5		
	Class 3	20		
	Class 4	10		
Daily Truck Volumes for 4 Classes	Class 1	385	386	394
	Class 2	30	30	30
	Class 3	119	119	121
	Class 4	59	59	61
Truck Factors for 4 Classes of Truck	Class 1	0.5		
	Class 2	2.3		
	Class 3	1.6		
	Class 4	5.5		
Weighted Average Truck Factor			**1.310**	
Daily ESALs per Truck Class	Class 1	193	193	197
	Class 2	68	68	70
	Class 3	190	190	194
	Class 4	326	326	333
Total Daily ESALs in Design Lane		**777**	**777**	**794**

3) Total ESALs for Base Year

Base Year	2031	2031	2041
Number of Days of Truck Traffic	365	365	365
Total ESALs for Base Year	**283,427**	**283,639**	**289,759**

4) Cumulative ESALs for the Design Period

Design Period (Years)	**19**	
Span of Design Periods	2031 to 2031	2031 to 2050
Average Rate of Increase in Truck Volume (%)		0.21
Years of Design Periods	0	19
Growth Factor	0.00	19.37
ESALs for the Design Periods	0	5,494,000
Cumulative ESALs for the Design Period	**5,494,295**	

Note: The ESAL calculations are baesd on the guidelines "Procedures for Estimating Traffic Loads for Pavement Design" by Jerry Hajek, 1995, and on MTO's "Adaptation and Verification of AASHTO Pavement Design Guide for Ontario Conditions", March 19, 2008.

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Table B11
EQUIVALENT SINGLE AXLE LOAD CALCULATION

Durham-Scarborough Bus Rapid Transit (DS BRT)
Kingston Road
Section 11 - Rotherglen Road South to Salem Road

1) Traffic Analysis

Traffic Data Year		2018		2031	2041
Design Year		**2031**			
Traffic Analysis Period			13	10	
Average Annual Daily Traffic (AADT)		35,246		36,346	37,046
Average Rate of Increase in Traffic (%)			0.24	0.19	
Truck Fraction of Total Traffic (%)		2.30		2.30	2.30
Average Rate of Increase in Truck Fraction (%)			0.00	0.00	
Number of Lanes in One Direction		3		3	3
Directional Factor		0.5		0.5	0.5
Lane Distribution Factor		0.7		0.7	0.7
Daily Truck Volume		**292**		**292**	**298**

2) Daily ESALs Analysis

Road Classification		***Urban Minor Arterial***		
Traffic Analysis Base Year		2031	2031	2041
Breakdown of Truck Proportions (%)	Class 1	65		
	Class 2	5		
	Class 3	20		
	Class 4	10		
Daily Truck Volumes for 4 Classes	Class 1	190	190	194
	Class 2	15	15	15
	Class 3	58	58	60
	Class 4	29	29	30
Truck Factors for 4 Classes of Truck	Class 1	0.5		
	Class 2	2.3		
	Class 3	1.6		
	Class 4	5.5		
Weighted Average Truck Factor			**1.310**	
Daily ESALs per Truck Class	Class 1	95	95	97
	Class 2	34	34	34
	Class 3	94	94	95
	Class 4	161	161	164
Total Daily ESALs in Design Lane		**383**	**383**	**390**

3) Total ESALs for Base Year

Base Year	2031	2031	2041
Number of Days of Truck Traffic	365	365	365
Total ESALs for Base Year	**139,786**	**139,739**	**142,417**

4) Cumulative ESALs for the Design Period

Design Period (Years)	**19**	
Span of Design Periods	2031 to 2031	2031 to 2050
Average Rate of Increase in Truck Volume (%)		0.19
Years of Design Periods	0	19
Growth Factor	0.00	19.33
ESALs for the Design Periods	0	2,701,000
Cumulative ESALs for the Design Period	**2,701,172**	

Note: The ESAL calculations are baesd on the guidelines "Procedures for Estimating Traffic Loads for Pavement Design" by Jerry Hajek, 1995, and on MTO's "Adaptation and Verification of AASHTO Pavement Design Guide for Ontario Conditions", March 19, 2008.

Table B12
EQUIVALENT SINGLE AXLE LOAD CALCULATION

Durham-Scarborough Bus Rapid Transit (DS BRT)
Kingston Road
Section 12 - Salem Road to Lakeridge Road

1) Traffic Analysis

Traffic Data Year		2018	2031	2041
Design Year		**2031**		
Traffic Analysis Period		13	10	
Average Annual Daily Traffic (AADT)		35,246	36,346	37,046
Average Rate of Increase in Traffic (%)		0.24	0.19	
Truck Fraction of Total Traffic (%)		2.30	2.30	2.30
Average Rate of Increase in Truck Fraction (%)		0.00	0.00	
Number of Lanes in One Direction		2	2	2
Directional Factor		0.5	0.5	0.5
Lane Distribution Factor		0.8	0.8	0.8
Daily Truck Volume		**334**	**334**	**340**

2) Daily ESALs Analysis

Road Classification		***Rural Minor Arterial***		
Traffic Analysis Base Year		2031	2031	2041
Breakdown of Truck Proportions (%)	Class 1	45		
	Class 2	5		
	Class 3	35		
	Class 4	15		
Daily Truck Volumes for 4 Classes	Class 1	150	150	153
	Class 2	17	17	17
	Class 3	117	117	119
	Class 4	50	50	51
Truck Factors for 4 Classes of Truck	Class 1	0.5		
	Class 2	2.3		
	Class 3	1.6		
	Class 4	5.5		
Weighted Average Truck Factor			**1.725**	
Daily ESALs per Truck Class	Class 1	75	75	77
	Class 2	38	38	39
	Class 3	187	187	191
	Class 4	276	276	281
Total Daily ESALs in Design Lane		**576**	**576**	**587**

3) Total ESALs for Base Year

Base Year	2031	2031	2041
Number of Days of Truck Traffic	365	365	365
Total ESALs for Base Year	**210,365**	**210,295**	**214,324**

4) Cumulative ESALs for the Design Period

Design Period (Years)	**19**	
Span of Design Periods	2031 to 2031	2031 to 2050
Average Rate of Increase in Truck Volume (%)		0.19
Years of Design Periods	0	19
Growth Factor	0.00	19.33
ESALs for the Design Periods	0	4,065,000
Cumulative ESALs for the Design Period	**4,065,013**	

Note: The ESAL calculations are baesd on the guidelines "Procedures for Estimating Traffic Loads for Pavement Design" by Jerry Hajek, 1995, and on MTO's "Adaptation and Verification of AASHTO Pavement Design Guide for Ontario Conditions", March 19, 2008.

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Checked by: _____

Table B13
EQUIVALENT SINGLE AXLE LOAD CALCULATION

Durham-Scarborough Bus Rapid Transit (DS BRT)
Dundas Street East
Section 13 - Lakeridge Road to Fothergill Court

1) Traffic Analysis

	2018		2031		2041
Traffic Data Year					
Design Year	**2031**				
Traffic Analysis Period		13		10	
Average Annual Daily Traffic (AADT)	27,849		29,949		31,749
Average Rate of Increase in Traffic (%)		0.56		0.59	
Truck Fraction of Total Traffic (%)	2.80		2.80		2.80
Average Rate of Increase in Truck Fraction (%)		0.00		0.00	
Number of Lanes in One Direction	2		2		2
Directional Factor	0.5		0.5		0.5
Lane Distribution Factor	0.8		0.8		0.8
Daily Truck Volume	**336**		**336**		**356**

2) Daily ESALs Analysis

Road Classification		***Urban Minor Arterial***		
Traffic Analysis Base Year		2031	2031	2041
Breakdown of Truck Proportions (%)	Class 1	65		
	Class 2	5		
	Class 3	20		
	Class 4	10		
Daily Truck Volumes for 4 Classes	Class 1	218	218	231
	Class 2	17	17	18
	Class 3	67	67	71
	Class 4	34	34	36
Truck Factors for 4 Classes of Truck	Class 1	0.5		
	Class 2	2.3		
	Class 3	1.6		
	Class 4	5.5		
Weighted Average Truck Factor			**1.310**	
Daily ESALs per Truck Class	Class 1	109	109	116
	Class 2	39	39	41
	Class 3	107	107	114
	Class 4	185	185	196
Total Daily ESALs in Design Lane		**440**	**440**	**466**

3) Total ESALs for Base Year

Base Year	2031	2031	2041
Number of Days of Truck Traffic	365	365	365
Total ESALs for Base Year	**160,432**	**160,467**	**170,030**

4) Cumulative ESALs for the Design Period

Design Period (Years)	**19**	
Span of Design Periods	2031 to 2031	2031 to 2050
Average Rate of Increase in Truck Volume (%)		0.58
Years of Design Periods	0	19
Growth Factor	0.00	20.03
ESALs for the Design Periods	0	3,215,000
Cumulative ESALs for the Design Period	**3,214,952**	

Note: The ESAL calculations are baesd on the guidelines "Procedures for Estimating Traffic Loads for Pavement Design" by Jerry Hajek, 1995, and on MTO's "Adaptation and Verification of AASHTO Pavement Design Guide for Ontario Conditions", March 19, 2008.

Table B14
EQUIVALENT SINGLE AXLE LOAD CALCULATION

Durham-Scarborough Bus Rapid Transit (DS BRT)
Dundas Street East
Section 14 - Fothergill Court to Jeffrey Street

1) Traffic Analysis

Traffic Data Year		2018		2031	2041
Design Year		**2031**			
Traffic Analysis Period			13		10
Average Annual Daily Traffic (AADT)		27,849		29,949	31,749
Average Rate of Increase in Traffic (%)			0.56		0.59
Truck Fraction of Total Traffic (%)		2.80		2.80	2.80
Average Rate of Increase in Truck Fraction (%)			0.00		0.00
Number of Lanes in One Direction		2		2	2
Directional Factor		0.5		0.5	0.5
Lane Distribution Factor		0.8		0.8	0.8
Daily Truck Volume		**336**		**336**	**356**

2) Daily ESALs Analysis

Road Classification		***Urban Minor Arterial***		
Traffic Analysis Base Year		2031	2031	2041
Breakdown of Truck Proportions (%)	Class 1	65		
	Class 2	5		
	Class 3	20		
	Class 4	10		
Daily Truck Volumes for 4 Classes	Class 1	218	218	231
	Class 2	17	17	18
	Class 3	67	67	71
	Class 4	34	34	36
Truck Factors for 4 Classes of Truck	Class 1	0.5		
	Class 2	2.3		
	Class 3	1.6		
	Class 4	5.5		
Weighted Average Truck Factor			**1.310**	
Daily ESALs per Truck Class	Class 1	109	109	116
	Class 2	39	39	41
	Class 3	107	107	114
	Class 4	185	185	196
Total Daily ESALs in Design Lane		**440**	**440**	**466**

3) Total ESALs for Base Year

Base Year	2031	2031	2041
Number of Days of Truck Traffic	365	365	365
Total ESALs for Base Year	**160,432**	**160,467**	**170,030**

4) Cumulative ESALs for the Design Period

Design Period (Years)	**19**	
Span of Design Periods	2031 to 2031	2031 to 2050
Average Rate of Increase in Truck Volume (%)		0.58
Years of Design Periods	0	19
Growth Factor	0.00	20.03
ESALs for the Design Periods	0	3,215,000
Cumulative ESALs for the Design Period	**3,214,952**	

Note: The ESAL calculations are baesd on the guidelines "Procedures for Estimating Traffic Loads for Pavement Design" by Jerry Hajek, 1995, and on MTO's "Adaptation and Verification of AASHTO Pavement Design Guide for Ontario Conditions", March 19, 2008.

Table B15
EQUIVALENT SINGLE AXLE LOAD CALCULATION

Durham-Scarborough Bus Rapid Transit (DS BRT)
Dundas Street East
Section 15 - Jeffrey Street to Annes Street

1) Traffic Analysis

Traffic Data Year		2018		2031	2041
Design Year		**2031**			
Traffic Analysis Period			13		10
Average Annual Daily Traffic (AADT)		27,849		29,949	31,749
Average Rate of Increase in Traffic (%)			0.56		0.59
Truck Fraction of Total Traffic (%)		2.55		2.55	2.55
Average Rate of Increase in Truck Fraction (%)			0.02		0.00
Number of Lanes in One Direction		2		2	2
Directional Factor		0.5		0.5	0.5
Lane Distribution Factor		0.8		0.8	0.8
Daily Truck Volume		**305**		**306**	**324**

2) Daily ESALs Analysis

Road Classification		***Urban Minor Arterial***		
Traffic Analysis Base Year		2031	2031	2041
Breakdown of Truck Proportions (%)	Class 1	65		
	Class 2	5		
	Class 3	20		
	Class 4	10		
Daily Truck Volumes for 4 Classes	Class 1	198	199	211
	Class 2	15	15	16
	Class 3	61	61	65
	Class 4	30	31	32
Truck Factors for 4 Classes of Truck	Class 1	0.5		
	Class 2	2.3		
	Class 3	1.6		
	Class 4	5.5		
Weighted Average Truck Factor			**1.310**	
Daily ESALs per Truck Class	Class 1	99	99	105
	Class 2	35	35	37
	Class 3	98	98	104
	Class 4	168	168	178
Total Daily ESALs in Design Lane		**400**	**400**	**424**

3) Total ESALs for Base Year

Base Year	2031	2031	2041
Number of Days of Truck Traffic	365	365	365
Total ESALs for Base Year	**145,829**	**146,123**	**154,921**

4) Cumulative ESALs for the Design Period

Design Period (Years)	**19**	
Span of Design Periods	2031 to 2031	2031 to 2050
Average Rate of Increase in Truck Volume (%)		0.59
Years of Design Periods	0	19
Growth Factor	0.00	20.03
ESALs for the Design Periods	0	2,928,000
Cumulative ESALs for the Design Period	**2,927,561**	

Note: The ESAL calculations are baesd on the guidelines "Procedures for Estimating Traffic Loads for Pavement Design" by Jerry Hajek, 1995, and on MTO's "Adaptation and Verification of AASHTO Pavement Design Guide for Ontario Conditions", March 19, 2008.

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Checked by: _____

Table B16
EQUIVALENT SINGLE AXLE LOAD CALCULATION

Durham-Scarborough Bus Rapid Transit (DS BRT)
Dundas Street East
Section 16 - Annes Street to Brock Street

1) Traffic Analysis

	2018		2031		2041
Traffic Data Year					
Design Year	**2031**				
Traffic Analysis Period		13		10	
Average Annual Daily Traffic (AADT)	27,849		28,649		29,249
Average Rate of Increase in Traffic (%)		0.22		0.21	
Truck Fraction of Total Traffic (%)	1.84		1.85		1.85
Average Rate of Increase in Truck Fraction (%)		0.02		0.00	
Number of Lanes in One Direction	2		2		2
Directional Factor	0.5		0.5		0.5
Lane Distribution Factor	0.8		0.8		0.8
Daily Truck Volume	**211**		**212**		**216**

2) Daily ESALs Analysis

Road Classification		***Urban Minor Arterial***		
Traffic Analysis Base Year		2031	2031	2041
Breakdown of Truck Proportions (%)	Class 1	65		
	Class 2	5		
	Class 3	20		
	Class 4	10		
Daily Truck Volumes for 4 Classes	Class 1	137	138	140
	Class 2	11	11	11
	Class 3	42	42	43
	Class 4	21	21	22
Truck Factors for 4 Classes of Truck	Class 1	0.5		
	Class 2	2.3		
	Class 3	1.6		
	Class 4	5.5		
Weighted Average Truck Factor			**1.310**	
Daily ESALs per Truck Class	Class 1	69	69	70
	Class 2	24	24	25
	Class 3	68	68	69
	Class 4	116	116	119
Total Daily ESALs in Design Lane		**277**	**277**	**283**

3) Total ESALs for Base Year

	2031	2031	2041
Base Year			
Number of Days of Truck Traffic	365	365	365
Total ESALs for Base Year	**100,935**	**101,177**	**103,280**

4) Cumulative ESALs for the Design Period

Design Period (Years)	**19**	
Span of Design Periods	2031 to 2031	2031 to 2050
Average Rate of Increase in Truck Volume (%)		0.21
Years of Design Periods	0	19
Growth Factor	0.00	19.36
ESALs for the Design Periods	0	1,959,000
Cumulative ESALs for the Design Period	**1,958,677**	

Note: The ESAL calculations are baesd on the guidelines "Procedures for Estimating Traffic Loads for Pavement Design" by Jerry Hajek, 1995, and on MTO's "Adaptation and Verification of AASHTO Pavement Design Guide for Ontario Conditions", March 19, 2008.

Table B17
EQUIVALENT SINGLE AXLE LOAD CALCULATION

Durham-Scarborough Bus Rapid Transit (DS BRT)
Dundas Street East
Section 17 - Brock Street to Hickory Street

1) Traffic Analysis

Traffic Data Year		2018	2031		2041
Design Year		**2031**			
Traffic Analysis Period			13	10	
Average Annual Daily Traffic (AADT)		27,849	28,649		29,349
Average Rate of Increase in Traffic (%)			0.22	0.24	
Truck Fraction of Total Traffic (%)		2.80	2.80		2.80
Average Rate of Increase in Truck Fraction (%)			-0.01	0.00	
Number of Lanes in One Direction		2	2		2
Directional Factor		0.5	0.5		0.5
Lane Distribution Factor		0.8	0.8		0.8
Daily Truck Volume		**321**	**321**		**329**

2) Daily ESALs Analysis

Road Classification			***Urban Minor Arterial***	
Traffic Analysis Base Year		2031	2031	2041
Breakdown of Truck Proportions (%)	Class 1	65		
	Class 2	5		
	Class 3	20		
	Class 4	10		
Daily Truck Volumes for 4 Classes	Class 1	209	209	214
	Class 2	16	16	16
	Class 3	64	64	66
	Class 4	32	32	33
Truck Factors for 4 Classes of Truck	Class 1	0.5		
	Class 2	2.3		
	Class 3	1.6		
	Class 4	5.5		
Weighted Average Truck Factor			**1.310**	
Daily ESALs per Truck Class	Class 1	104	104	107
	Class 2	37	37	38
	Class 3	103	103	105
	Class 4	177	176	181
Total Daily ESALs in Design Lane		**421**	**420**	**431**

3) Total ESALs for Base Year

Base Year	2031	2031	2041
Number of Days of Truck Traffic	365	365	365
Total ESALs for Base Year	**153,665**	**153,391**	**157,216**

4) Cumulative ESALs for the Design Period

Design Period (Years)	**19**	
Span of Design Periods	2031 to 2031	2031 to 2050
Average Rate of Increase in Truck Volume (%)		0.25
Years of Design Periods	0	19
Growth Factor	0.00	19.42
ESALs for the Design Periods	0	2,979,000
Cumulative ESALs for the Design Period	**2,978,692**	

Note: The ESAL calculations are baesd on the guidelines "Procedures for Estimating Traffic Loads for Pavement Design" by Jerry Hajek, 1995, and on MTO's "Adaptation and Verification of AASHTO Pavement Design Guide for Ontario Conditions", March 19, 2008.

Table B18
EQUIVALENT SINGLE AXLE LOAD CALCULATION

Durham-Scarborough Bus Rapid Transit (DS BRT)
Dundas Street East
Section 18 - Hickory Street to Garrard Street

1) Traffic Analysis

Traffic Data Year		2018	2031	2041
Design Year		**2031**		
Traffic Analysis Period		13	10	
Average Annual Daily Traffic (AADT)		20,872	21,472	21,972
Average Rate of Increase in Traffic (%)		0.22	0.23	
Truck Fraction of Total Traffic (%)		2.25	2.25	2.25
Average Rate of Increase in Truck Fraction (%)		0.01	-0.01	
Number of Lanes in One Direction		2	2	2
Directional Factor		0.5	0.5	0.5
Lane Distribution Factor		0.8	0.8	0.8
Daily Truck Volume		**193**	**194**	**198**

2) Daily ESALs Analysis

Road Classification			***Urban Minor Arterial***	
Traffic Analysis Base Year		2031	2031	2041
Breakdown of Truck Proportions (%)	Class 1	65		
	Class 2	5		
	Class 3	20		
	Class 4	10		
Daily Truck Volumes for 4 Classes	Class 1	126	126	129
	Class 2	10	10	10
	Class 3	39	39	40
	Class 4	19	19	20
Truck Factors for 4 Classes of Truck	Class 1	0.5		
	Class 2	2.3		
	Class 3	1.6		
	Class 4	5.5		
Weighted Average Truck Factor			**1.310**	
Daily ESALs per Truck Class	Class 1	63	63	64
	Class 2	22	22	23
	Class 3	62	62	63
	Class 4	106	106	109
Total Daily ESALs in Design Lane		**253**	**254**	**259**

3) Total ESALs for Base Year

Base Year	2031	2031	2041
Number of Days of Truck Traffic	365	365	365
Total ESALs for Base Year	**92,476**	**92,570**	**94,674**

4) Cumulative ESALs for the Design Period

Design Period (Years)	**19**	
Span of Design Periods	2031 to 2031	2031 to 2050
Average Rate of Increase in Truck Volume (%)		0.22
Years of Design Periods	0	19
Growth Factor	0.00	19.40
ESALs for the Design Periods	0	1,796,000
Cumulative ESALs for the Design Period	**1,795,788**	

Note: The ESAL calculations are baesd on the guidelines "Procedures for Estimating Traffic Loads for Pavement Design" by Jerry Hajek, 1995, and on MTO's "Adaptation and Verification of AASHTO Pavement Design Guide for Ontario Conditions", March 19, 2008.

Table B19
EQUIVALENT SINGLE AXLE LOAD CALCULATION

Durham-Scarborough Bus Rapid Transit (DS BRT)
King Street West
Sections 19 and 20 - Garrard Street to Simcoe Street

1) Traffic Analysis

Traffic Data Year		2018	2031	2041
Design Year		**2031**		
Traffic Analysis Period			13	10
Average Annual Daily Traffic (AADT)		20,608	21,708	22,708
Average Rate of Increase in Traffic (%)			0.40	0.45
Truck Fraction of Total Traffic (%)		3.38	2.90	2.90
Average Rate of Increase in Truck Fraction (%)			-1.17	0.00
Number of Lanes in One Direction		2	2	2
Directional Factor		0.5	0.5	0.5
Lane Distribution Factor		0.8	0.8	0.8
Daily Truck Volume		**294**	**252**	**264**

2) Daily ESALs Analysis

Road Classification			***Urban Minor Arterial***	
Traffic Analysis Base Year		2031	2031	2041
Breakdown of Truck Proportions (%)	Class 1	65		
	Class 2	5		
	Class 3	20		
	Class 4	10		
Daily Truck Volumes for 4 Classes	Class 1	191	164	171
	Class 2	15	13	13
	Class 3	59	50	53
	Class 4	29	25	26
Truck Factors for 4 Classes of Truck	Class 1	0.5		
	Class 2	2.3		
	Class 3	1.6		
	Class 4	5.5		
Weighted Average Truck Factor			**1.310**	
Daily ESALs per Truck Class	Class 1	95	82	86
	Class 2	34	29	30
	Class 3	94	81	84
	Class 4	162	139	145
Total Daily ESALs in Design Lane		**385**	**330**	**345**

3) Total ESALs for Base Year

Base Year	2031	2031	2041
Number of Days of Truck Traffic	365	365	365
Total ESALs for Base Year	**140,424**	**120,494**	**126,040**

4) Cumulative ESALs for the Design Period

Design Period (Years)	**19**	
Span of Design Periods	2031 to 2031	2031 to 2050
Average Rate of Increase in Truck Volume (%)		0.45
Years of Design Periods	0	19
Growth Factor	0.00	19.79
ESALs for the Design Periods	0	2,385,000
Cumulative ESALs for the Design Period	**2,384,809**	

Note: The ESAL calculations are baesd on the guidelines "Procedures for Estimating Traffic Loads for Pavement Design" by Jerry Hajek, 1995, and on MTO's "Adaptation and Verification of AASHTO Pavement Design Guide for Ontario Conditions", March 19, 2008.

Table B20
PAVEMENT DESIGN AND ANALYSIS - FLEXIBLE STRUCTURAL DESIGN MODULE

Durham-Scarborough Bus Rapid Transit (DS BRT)
Ellesmere Road
Section 1 - McCowan Road to Markham Road

Flexible Structural Design

80-kN ESALs Over Initial Performance Period	6,044,283
Initial Serviceability	4.4
Terminal Serviceability	2.4
Reliability Level (%)	90
Overall Standard Deviation	0.49
Roadbed Soil Resilient Modulus	30,000 kPa
Stage Construction	1.0
Calculated Design Structural Number	136

Specified Layer Design

Layer	Material Description	Struct Coef. (Ai)	Drain Coef. (Mi)	Thickness (Di) (mm)	Required Thickness (mm)	Calculated SN (mm)
1	New Hot Mix Asphalt	0.42	1.00	160	160	67
2	New Granular A Base	0.14	1.00	150	150	21
3	New Granular B,Type I	0.09	1.00	550	550	50
Total	-	-	-	860	860	138

Layered Thickness Design

Thickness precision

Layer	Material Description	Struct Coef. (Ai)	Drain Coef. (Mi)	Actual Spec Thickness (Di) (mm)	Actual Min Thickness (Di) (mm)	Elastic Modulus (kPa)	Calculated Thickness (mm)	Calculated SN (mm)
1	New Hot Mix Asphalt	0.42	1.00	-	-	2,750,000	155	65
2	New Granular A Base	0.14	1.00	-	-	250,000	96	13
3	New Granular B,Type I	0.09	1.00	-	-	150,000	635	57
Total	-	-	-	-	-	-	887	135

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Designed by: GBG
Checked by: _____

Table B21
PAVEMENT DESIGN AND ANALYSIS - FLEXIBLE STRUCTURAL DESIGN MODULE

Durham-Scarborough Bus Rapid Transit (DS BRT)
Ellesmere Road
Section 2 - Markham Road to Military Trail

Flexible Structural Design

80-kN ESALs Over Initial Performance Period	5,517,684
Initial Serviceability	4.4
Terminal Serviceability	2.4
Reliability Level (%)	90
Overall Standard Deviation	0.49
Roadbed Soil Resilient Modulus	30,000 kPa
Stage Construction	1.0
Calculated Design Structural Number	134

Specified Layer Design

Layer	Material Description	Struct Coef. (Ai)	Drain Coef. (Mi)	Thickness (Di) (mm)	Required Thickness (mm)	Calculated SN (mm)
1	New Hot Mix Asphalt	0.42	1.00	160	160	67
2	New Granular A Base	0.14	1.00	150	150	21
3	New Granular B,Type I	0.09	1.00	550	550	50
Total	-	-	-	860	860	138

Layered Thickness Design

Thickness precision

Layer	Material Description	Struct Coef. (Ai)	Drain Coef. (Mi)	Actual Spec Thickness (Di) (mm)	Actual Min Thickness (Di) (mm)	Elastic Modulus (kPa)	Calculated Thickness (mm)	Calculated SN (mm)
1	New Hot Mix Asphalt	0.42	1.00	-	-	2,750,000	153	64
2	New Granular A Base	0.14	1.00	-	-	250,000	95	13
3	New Granular B,Type I	0.09	1.00	-	-	150,000	629	57
Total	-	-	-	-	-	-	877	134

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Table B22
PAVEMENT DESIGN AND ANALYSIS - FLEXIBLE STRUCTURAL DESIGN MODULE

Durham-Scarborough Bus Rapid Transit (DS BRT)
Ellesmere Road
Section 3 - Military Trail toMorningside Avenue

Flexible Structural Design

80-kN ESALs Over Initial Performance Period	4,311,280
Initial Serviceability	4.4
Terminal Serviceability	2.4
Reliability Level (%)	90
Overall Standard Deviation	0.49
Roadbed Soil Resilient Modulus	30,000 kPa
Stage Construction	1.0
Calculated Design Structural Number	130

Specified Layer Design

Layer	Material Description	Struct Coef. (Ai)	Drain Coef. (Mi)	Thickness (Di) (mm)	Required Thickness (mm)	Calculated SN (mm)
1	New Hot Mix Asphalt	0.42	1.00	150	150	63
2	New Granular A Base	0.14	1.00	150	150	21
3	New Granular B,Type I	0.09	1.00	550	550	50
Total	-	-	-	850	850	134

Layered Thickness Design

Thickness precision

Layer	Material Description	Struct Coef. (Ai)	Drain Coef. (Mi)	Actual Spec Thickness (Di) (mm)	Actual Min Thickness (Di) (mm)	Elastic Modulus (kPa)	Calculated Thickness (mm)	Calculated SN (mm)
1	New Hot Mix Asphalt	0.42	1.00	-	-	2,750,000	147	62
2	New Granular A Base	0.14	1.00	-	-	250,000	91	13
3	New Granular B,Type I	0.09	1.00	-	-	150,000	613	55
Total	-	-	-	-	-	-	852	130

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Checked by: _____

Table B23
PAVEMENT DESIGN AND ANALYSIS - FLEXIBLE STRUCTURAL DESIGN MODULE

Durham-Scarborough Bus Rapid Transit (DS BRT)
Ellesmere Road and short section o Kingston Road
Section 4 - Morningside Avenue to Kingston Road and Kingston Road from Ellesmere Road to Highway 401

Flexible Structural Design

80-kN ESALs Over Initial Performance Period	3,095,768
Initial Serviceability	4.4
Terminal Serviceability	2.4
Reliability Level (%)	90
Overall Standard Deviation	0.49
Roadbed Soil Resilient Modulus	30,000 kPa
Stage Construction	1.0
Calculated Design Structural Number	124

Specified Layer Design

Layer	Material Description	Struct Coef. (Ai)	Drain Coef. (Mi)	Thickness (Di) (mm)	Required Thickness (mm)	Calculated SN (mm)
1	New Hot Mix Asphalt	0.42	1.00	150	150	63
2	New Granular A Base	0.14	1.00	150	150	21
3	New Granular B,Type I	0.09	1.00	450	450	41
Total	-	-	-	750	750	125

Layered Thickness Design

Thickness precision

Layer	Material Description	Struct Coef. (Ai)	Drain Coef. (Mi)	Actual Spec Thickness (Di) (mm)	Actual Min Thickness (Di) (mm)	Elastic Modulus (kPa)	Calculated Thickness (mm)	Calculated SN (mm)
1	New Hot Mix Asphalt	0.42	1.00	-	-	2,750,000	139	59
2	New Granular A Base	0.14	1.00	-	-	250,000	87	12
3	New Granular B,Type I	0.09	1.00	-	-	150,000	591	53
Total	-	-	-	-	-	-	818	124

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Table B24
PAVEMENT DESIGN AND ANALYSIS - FLEXIBLE STRUCTURAL DESIGN MODULE

Durham-Scarborough Bus Rapid Transit (DS BRT)
Ellesmere Road
Section 5 - Highway 401 to CN Rail

Flexible Structural Design

80-kN ESALs Over Initial Performance Period	9,746,767
Initial Serviceability	4.4
Terminal Serviceability	2.4
Reliability Level (%)	90
Overall Standard Deviation	0.49
Roadbed Soil Resilient Modulus	30,000 kPa
Stage Construction	1.0
Calculated Design Structural Number	145

Specified Layer Design

Layer	Material Description	Struct Coef. (Ai)	Drain Coef. (Mi)	Thickness (Di) (mm)	Required Thickness (mm)	Calculated SN (mm)
1	New Hot Mix Asphalt	0.42	1.00	160	160	67
2	New Granular A Base	0.14	1.00	250	250	35
3	New Granular B,Type I	0.09	1.00	500	500	45
Total	-	-	-	910	910	147

Layered Thickness Design

Thickness precision

Layer	Material Description	Struct Coef. (Ai)	Drain Coef. (Mi)	Actual Spec Thickness (Di) (mm)	Actual Min Thickness (Di) (mm)	Elastic Modulus (kPa)	Calculated Thickness (mm)	Calculated SN (mm)
1	New Hot Mix Asphalt	0.42	1.00	-	-	2,750,000	168	70
2	New Granular A Base	0.14	1.00	-	-	250,000	102	14
3	New Granular B,Type I	0.09	1.00	-	-	150,000	667	60
Total	-	-	-	-	-	-	937	144

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Table B25
PAVEMENT DESIGN AND ANALYSIS - FLEXIBLE STRUCTURAL DESIGN MODULE

Durham-Scarborough Bus Rapid Transit (DS BRT)
Kingston Road
Section 6 - The CN Rail to Liverpool Road

Flexible Structural Design

80-kN ESALs Over Initial Performance Period	3,080,330
Initial Serviceability	4.4
Terminal Serviceability	2.4
Reliability Level (%)	90
Overall Standard Deviation	0.49
Roadbed Soil Resilient Modulus	30,000 kPa
Stage Construction	1.0
Calculated Design Structural Number	124

Specified Layer Design

Layer	Material Description	Struct Coef. (Ai)	Drain Coef. (Mi)	Thickness (Di) (mm)	Required Thickness (mm)	Calculated SN (mm)
1	New Hot Mix Asphalt	0.42	1.00	160	160	67
2	New Granular A Base	0.14	1.00	250	250	35
3	New Granular B,Type I	0.09	1.00	300	300	27
Total	-	-	-	710	710	129

Layered Thickness Design

Thickness precision

Layer	Material Description	Struct Coef. (Ai)	Drain Coef. (Mi)	Actual Spec Thickness (Di) (mm)	Actual Min Thickness (Di) (mm)	Elastic Modulus (kPa)	Calculated Thickness (mm)	Calculated SN (mm)
1	New Hot Mix Asphalt	0.42	1.00	-	-	2,750,000	139	59
2	New Granular A Base	0.14	1.00	-	-	250,000	87	12
3	New Granular B,Type I	0.09	1.00	-	-	150,000	591	53
Total	-	-	-	-	-	-	817	124

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Designed by: GBG
Checked by: _____

Table B26
PAVEMENT DESIGN AND ANALYSIS - FLEXIBLE STRUCTURAL DESIGN MODULE

Durham-Scarborough Bus Rapid Transit (DS BRT)
Kingston Road
Section 7 - Liverpool Road to Glengrove Road

Flexible Structural Design

80-kN ESALs Over Initial Performance Period	4,812,777
Initial Serviceability	4.4
Terminal Serviceability	2.4
Reliability Level (%)	90
Overall Standard Deviation	0.49
Roadbed Soil Resilient Modulus	30,000 kPa
Stage Construction	1.0
Calculated Design Structural Number	132

Specified Layer Design

Layer	Material Description	Struct Coef. (Ai)	Drain Coef. (Mi)	Thickness (Di) (mm)	Required Thickness (mm)	Calculated SN (mm)
1	New Hot Mix Asphalt	0.42	1.00	160	160	67
2	New Granular A Base	0.14	1.00	250	250	35
3	New Granular B,Type I	0.09	1.00	350	350	32
Total	-	-	-	760	760	134

Layered Thickness Design

Thickness precision

Layer	Material Description	Struct Coef. (Ai)	Drain Coef. (Mi)	Actual Spec Thickness (Di) (mm)	Actual Min Thickness (Di) (mm)	Elastic Modulus (kPa)	Calculated Thickness (mm)	Calculated SN (mm)
1	New Hot Mix Asphalt	0.42	1.00	-	-	2,750,000	150	63
2	New Granular A Base	0.14	1.00	-	-	250,000	93	13
3	New Granular B,Type I	0.09	1.00	-	-	150,000	620	56
Total	-	-	-	-	-	-	863	132

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Table B27
PAVEMENT DESIGN AND ANALYSIS - FLEXIBLE STRUCTURAL DESIGN MODULE

Durham-Scarborough Bus Rapid Transit (DS BRT)
Kingston Road
Section 8 - Glengrove Road to Royal Road

Flexible Structural Design

80-kN ESALs Over Initial Performance Period	4,812,777
Initial Serviceability	4.4
Terminal Serviceability	2.4
Reliability Level (%)	90
Overall Standard Deviation	0.49
Roadbed Soil Resilient Modulus	30,000 kPa
Stage Construction	1.0
Calculated Design Structural Number	132

Specified Layer Design

Layer	Material Description	Struct Coef. (Ai)	Drain Coef. (Mi)	Thickness (Di) (mm)	Required Thickness (mm)	Calculated SN (mm)
1	New Hot Mix Asphalt	0.42	1.00	160	160	67
2	New Granular A Base	0.14	1.00	250	250	35
3	New Granular B,Type I	0.09	1.00	350	350	32
Total	-	-	-	760	760	134

Layered Thickness Design

Thickness precision

Layer	Material Description	Struct Coef. (Ai)	Drain Coef. (Mi)	Actual Spec Thickness (Di) (mm)	Actual Min Thickness (Di) (mm)	Elastic Modulus (kPa)	Calculated Thickness (mm)	Calculated SN (mm)
1	New Hot Mix Asphalt	0.42	1.00	-	-	2,750,000	150	63
2	New Granular A Base	0.14	1.00	-	-	250,000	93	13
3	New Granular B,Type I	0.09	1.00	-	-	150,000	620	56
Total	-	-	-	-	-	-	863	132

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Checked by: _____

Table B28
PAVEMENT DESIGN AND ANALYSIS - FLEXIBLE STRUCTURAL DESIGN MODULE

Durham-Scarborough Bus Rapid Transit (DS BRT)
Kingston Road
Section 9 - Royal Road to Southview Drive

Flexible Structural Design

80-kN ESALs Over Initial Performance Period	3,865,483
Initial Serviceability	4.4
Terminal Serviceability	2.4
Reliability Level (%)	90
Overall Standard Deviation	0.49
Roadbed Soil Resilient Modulus	30,000 kPa
Stage Construction	1.0
Calculated Design Structural Number	128

Specified Layer Design

Layer	Material Description	Struct Coef. (Ai)	Drain Coef. (Mi)	Thickness (Di) (mm)	Required Thickness (mm)	Calculated SN (mm)
1	New Hot Mix Asphalt	0.42	1.00	160	160	67
2	New Granular A Base	0.14	1.00	250	250	35
3	New Granular B,Type I	0.09	1.00	300	300	27
Total	-	-	-	710	710	129

Layered Thickness Design

Thickness precision

Layer	Material Description	Struct Coef. (Ai)	Drain Coef. (Mi)	Actual Spec Thickness (Di) (mm)	Actual Min Thickness (Di) (mm)	Elastic Modulus (kPa)	Calculated Thickness (mm)	Calculated SN (mm)
1	New Hot Mix Asphalt	0.42	1.00	-	-	2,750,000	145	61
2	New Granular A Base	0.14	1.00	-	-	250,000	90	13
3	New Granular B,Type I	0.09	1.00	-	-	150,000	606	55
Total	-	-	-	-	-	-	840	129

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Table B29
PAVEMENT DESIGN AND ANALYSIS - FLEXIBLE STRUCTURAL DESIGN MODULE

Durham-Scarborough Bus Rapid Transit (DS BRT)
Kingston Road
Section 10 - Southview Drive to Rotherglen Road South

Flexible Structural Design

80-kN ESALs Over Initial Performance Period	5,494,295
Initial Serviceability	4.4
Terminal Serviceability	2.4
Reliability Level (%)	90
Overall Standard Deviation	0.49
Roadbed Soil Resilient Modulus	30,000 kPa
Stage Construction	1.0
Calculated Design Structural Number	134

Specified Layer Design

Layer	Material Description	Struct Coef. (Ai)	Drain Coef. (Mi)	Thickness (Di) (mm)	Required Thickness (mm)	Calculated SN (mm)
1	New Hot Mix Asphalt	0.42	1.00	160	160	67
2	New Granular A Base	0.14	1.00	250	250	35
3	New Granular B,Type I	0.09	1.00	400	400	36
Total	-	-	-	810	810	138

Layered Thickness Design

Thickness precision

Layer	Material Description	Struct Coef. (Ai)	Drain Coef. (Mi)	Actual Spec Thickness (Di) (mm)	Actual Min Thickness (Di) (mm)	Elastic Modulus (kPa)	Calculated Thickness (mm)	Calculated SN (mm)
1	New Hot Mix Asphalt	0.42	1.00	-	-	2,750,000	153	64
2	New Granular A Base	0.14	1.00	-	-	250,000	95	13
3	New Granular B,Type I	0.09	1.00	-	-	150,000	629	57
Total	-	-	-	-	-	-	877	134

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Table B30
PAVEMENT DESIGN AND ANALYSIS - FLEXIBLE STRUCTURAL DESIGN MODULE

Durham-Scarborough Bus Rapid Transit (DS BRT)
Kingston Road
Section 11 - Rotherglen Road South to Salem Road

Flexible Structural Design

80-kN ESALs Over Initial Performance Period	2,701,172
Initial Serviceability	4.4
Terminal Serviceability	2.4
Reliability Level (%)	90
Overall Standard Deviation	0.49
Roadbed Soil Resilient Modulus	30,000 kPa
Stage Construction	1.0
Calculated Design Structural Number	122

Specified Layer Design

Layer	Material Description	Struct Coef. (Ai)	Drain Coef. (Mi)	Thickness (Di) (mm)	Required Thickness (mm)	Calculated SN (mm)
1	New Hot Mix Asphalt	0.42	1.00	160	160	67
2	New Granular A Base	0.14	1.00	250	250	35
3	New Granular B,Type I	0.09	1.00	300	300	27
Total	-	-	-	710	710	129

Layered Thickness Design

Thickness precision

Layer	Material Description	Struct Coef. (Ai)	Drain Coef. (Mi)	Actual Spec Thickness (Di) (mm)	Actual Min Thickness (Di) (mm)	Elastic Modulus (kPa)	Calculated Thickness (mm)	Calculated SN (mm)
1	New Hot Mix Asphalt	0.42	1.00	-	-	2,750,000	136	57
2	New Granular A Base	0.14	1.00	-	-	250,000	86	12
3	New Granular B,Type I	0.09	1.00	-	-	150,000	582	52
Total	-	-	-	-	-	-	804	121

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Designed by: GBG
Checked by: _____

Table B31
PAVEMENT DESIGN AND ANALYSIS - FLEXIBLE STRUCTURAL DESIGN MODULE

Durham-Scarborough Bus Rapid Transit (DS BRT)
Kingston Road
Section 12 - Salem Road to Lakeridge Road

Flexible Structural Design

80-kN ESALs Over Initial Performance Period	4,065,013
Initial Serviceability	4.4
Terminal Serviceability	2.4
Reliability Level (%)	90
Overall Standard Deviation	0.49
Roadbed Soil Resilient Modulus	30,000 kPa
Stage Construction	1.0
Calculated Design Structural Number	129

Specified Layer Design

Layer	Material Description	Struct Coef. (Ai)	Drain Coef. (Mi)	Thickness (Di) (mm)	Required Thickness (mm)	Calculated SN (mm)
1	New Hot Mix Asphalt	0.42	1.00	160	160	67
2	New Granular A Base	0.14	1.00	250	250	35
3	New Granular B,Type I	0.09	1.00	300	300	27
Total	-	-	-	710	710	129

Layered Thickness Design

Thickness precision

Layer	Material Description	Struct Coef. (Ai)	Drain Coef. (Mi)	Actual Spec Thickness (Di) (mm)	Actual Min Thickness (Di) (mm)	Elastic Modulus (kPa)	Calculated Thickness (mm)	Calculated SN (mm)
1	New Hot Mix Asphalt	0.42	1.00	-	-	2,750,000	146	61
2	New Granular A Base	0.14	1.00	-	-	250,000	91	13
3	New Granular B,Type I	0.09	1.00	-	-	150,000	609	55
Total	-	-	-	-	-	-	846	129

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Designed by: GBG
Checked by: _____

Table B32
PAVEMENT DESIGN AND ANALYSIS - FLEXIBLE STRUCTURAL DESIGN MODULE

Durham-Scarborough Bus Rapid Transit (DS BRT)
Kingston Road
Section 13 - Lakeridge Road to Fothergill Court

Flexible Structural Design

80-kN ESALs Over Initial Performance Period	3,214,952
Initial Serviceability	4.4
Terminal Serviceability	2.4
Reliability Level (%)	90
Overall Standard Deviation	0.49
Roadbed Soil Resilient Modulus	30,000 kPa
Stage Construction	1.0
Calculated Design Structural Number	125

Specified Layer Design

Layer	Material Description	Struct Coef. (Ai)	Drain Coef. (Mi)	Thickness (Di) (mm)	Required Thickness (mm)	Calculated SN (mm)
1	New Hot Mix Asphalt	0.42	1.00	160	160	67
2	New Granular A Base	0.14	1.00	250	250	35
3	New Granular B,Type I	0.09	1.00	300	300	27
Total	-	-	-	710	710	129

Layered Thickness Design

Thickness precision

Layer	Material Description	Struct Coef. (Ai)	Drain Coef. (Mi)	Actual Spec Thickness (Di) (mm)	Actual Min Thickness (Di) (mm)	Elastic Modulus (kPa)	Calculated Thickness (mm)	Calculated SN (mm)
1	New Hot Mix Asphalt	0.42	1.00	-	-	2,750,000	140	59
2	New Granular A Base	0.14	1.00	-	-	250,000	88	12
3	New Granular B,Type I	0.09	1.00	-	-	150,000	594	53
Total	-	-	-	-	-	-	822	124

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Table B33
PAVEMENT DESIGN AND ANALYSIS - FLEXIBLE STRUCTURAL DESIGN MODULE

Durham-Scarborough Bus Rapid Transit (DS BRT)
Dundas Street East
Section 14 - Fothergill Court to Jeffrey Street

Flexible Structural Design

80-kN ESALs Over Initial Performance Period	3,214,952
Initial Serviceability	4.4
Terminal Serviceability	2.4
Reliability Level (%)	90
Overall Standard Deviation	0.49
Roadbed Soil Resilient Modulus	30,000 kPa
Stage Construction	1.0
Calculated Design Structural Number	125

Specified Layer Design

Layer	Material Description	Struct Coef. (Ai)	Drain Coef. (Mi)	Thickness (Di) (mm)	Required Thickness (mm)	Calculated SN (mm)
1	New Hot Mix Asphalt	0.42	1.00	160	160	67
2	New Granular A Base	0.14	1.00	250	250	35
3	New Granular B,Type I	0.09	1.00	300	300	27
Total	-	-	-	710	710	129

Layered Thickness Design

Thickness precision

Layer	Material Description	Struct Coef. (Ai)	Drain Coef. (Mi)	Actual Spec Thickness (Di) (mm)	Actual Min Thickness (Di) (mm)	Elastic Modulus (kPa)	Calculated Thickness (mm)	Calculated SN (mm)
1	New Hot Mix Asphalt	0.42	1.00	-	-	2,750,000	140	59
2	New Granular A Base	0.14	1.00	-	-	250,000	88	12
3	New Granular B,Type I	0.09	1.00	-	-	150,000	594	53
Total	-	-	-	-	-	-	822	124

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Table B34
PAVEMENT DESIGN AND ANALYSIS - FLEXIBLE STRUCTURAL DESIGN MODULE

Durham-Scarborough Bus Rapid Transit (DS BRT)
Dundas Street East
Section 15 - Jeffrey Street to Annes Street

Flexible Structural Design

80-kN ESALs Over Initial Performance Period	2,927,561
Initial Serviceability	4.4
Terminal Serviceability	2.4
Reliability Level (%)	90
Overall Standard Deviation	0.49
Roadbed Soil Resilient Modulus	30,000 kPa
Stage Construction	1.0
Calculated Design Structural Number	123

Specified Layer Design

Layer	Material Description	Struct Coef. (Ai)	Drain Coef. (Mi)	Thickness (Di) (mm)	Required Thickness (mm)	Calculated SN (mm)
1	New Hot Mix Asphalt	0.42	1.00	160	160	67
2	New Granular A Base	0.14	1.00	250	250	35
3	New Granular B,Type I	0.09	1.00	300	300	27
Total	-	-	-	710	710	129

Layered Thickness Design

Thickness precision

Layer	Material Description	Struct Coef. (Ai)	Drain Coef. (Mi)	Actual Spec Thickness (Di) (mm)	Actual Min Thickness (Di) (mm)	Elastic Modulus (kPa)	Calculated Thickness (mm)	Calculated SN (mm)
1	New Hot Mix Asphalt	0.42	1.00	-	-	2,750,000	138	58
2	New Granular A Base	0.14	1.00	-	-	250,000	87	12
3	New Granular B,Type I	0.09	1.00	-	-	150,000	587	53
Total	-	-	-	-	-	-	812	123

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Designed by: GBG
Checked by: _____

Table B35
PAVEMENT DESIGN AND ANALYSIS - FLEXIBLE STRUCTURAL DESIGN MODULE

Durham-Scarborough Bus Rapid Transit (DS BRT)
Dundas Street East
Section 16 - Annes Street to Brock Street

Flexible Structural Design

80-kN ESALs Over Initial Performance Period	1,958,677
Initial Serviceability	4.4
Terminal Serviceability	2.4
Reliability Level (%)	90
Overall Standard Deviation	0.49
Roadbed Soil Resilient Modulus	30,000 kPa
Stage Construction	1.0
Calculated Design Structural Number	116

Specified Layer Design

Layer	Material Description	Struct Coef. (Ai)	Drain Coef. (Mi)	Thickness (Di) (mm)	Required Thickness (mm)	Calculated SN (mm)
1	New Hot Mix Asphalt	0.42	1.00	160	160	67
2	New Granular A Base	0.14	1.00	250	250	35
3	New Granular B,Type I	0.09	1.00	300	300	27
Total	-	-	-	710	710	129

Layered Thickness Design

Thickness precision

Layer	Material Description	Struct Coef. (Ai)	Drain Coef. (Mi)	Actual Spec Thickness (Di) (mm)	Actual Min Thickness (Di) (mm)	Elastic Modulus (kPa)	Calculated Thickness (mm)	Calculated SN (mm)
1	New Hot Mix Asphalt	0.42	1.00	-	-	2,750,000	129	54
2	New Granular A Base	0.14	1.00	-	-	250,000	82	11
3	New Granular B,Type I	0.09	1.00	-	-	150,000	561	50
Total	-	-	-	-	-	-	772	115

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Table B36
PAVEMENT DESIGN AND ANALYSIS - FLEXIBLE STRUCTURAL DESIGN MODULE

Durham-Scarborough Bus Rapid Transit (DS BRT)
Dundas Street East
Section 17 - Brock Street to Hickory Street

Flexible Structural Design

80-kN ESALs Over Initial Performance Period	2,978,692
Initial Serviceability	4.4
Terminal Serviceability	2.4
Reliability Level (%)	90
Overall Standard Deviation	0.49
Roadbed Soil Resilient Modulus	30,000 kPa
Stage Construction	1.0
Calculated Design Structural Number	123

Specified Layer Design

Layer	Material Description	Struct Coef. (Ai)	Drain Coef. (Mi)	Thickness (Di) (mm)	Required Thickness (mm)	Calculated SN (mm)
1	New Hot Mix Asphalt	0.42	1.00	160	160	67
2	New Granular A Base	0.14	1.00	250	250	35
3	New Granular B,Type I	0.09	1.00	300	300	27
Total	-	-	-	710	710	129

Layered Thickness Design

Thickness precision

Layer	Material Description	Struct Coef. (Ai)	Drain Coef. (Mi)	Actual Spec Thickness (Di) (mm)	Actual Min Thickness (Di) (mm)	Elastic Modulus (kPa)	Calculated Thickness (mm)	Calculated SN (mm)
1	New Hot Mix Asphalt	0.42	1.00	-	-	2,750,000	139	58
2	New Granular A Base	0.14	1.00	-	-	250,000	87	12
3	New Granular B,Type I	0.09	1.00	-	-	150,000	588	53
Total	-	-	-	-	-	-	814	123

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Designed by: GBG
Checked by: _____

Table B37
PAVEMENT DESIGN AND ANALYSIS - FLEXIBLE STRUCTURAL DESIGN MODULE

Durham-Scarborough Bus Rapid Transit (DS BRT)
Dundas Street East
Section 18 - Hickory Street to Garrard Street

Flexible Structural Design

80-kN ESALs Over Initial Performance Period	1,795,788
Initial Serviceability	4.4
Terminal Serviceability	2.4
Reliability Level (%)	90
Overall Standard Deviation	0.49
Roadbed Soil Resilient Modulus	30,000 kPa
Stage Construction	1.0
Calculated Design Structural Number	115

Specified Layer Design

Layer	Material Description	Struct Coef. (Ai)	Drain Coef. (Mi)	Thickness (Di) (mm)	Required Thickness (mm)	Calculated SN (mm)
1	New Hot Mix Asphalt	0.42	1.00	160	160	67
2	New Granular A Base	0.14	1.00	250	250	35
3	New Granular B,Type I	0.09	1.00	300	300	27
Total	-	-	-	710	710	129

Layered Thickness Design

Thickness precision

Layer	Material Description	Struct Coef. (Ai)	Drain Coef. (Mi)	Actual Spec Thickness (Di) (mm)	Actual Min Thickness (Di) (mm)	Elastic Modulus (kPa)	Calculated Thickness (mm)	Calculated SN (mm)
1	New Hot Mix Asphalt	0.42	1.00	-	-	2,750,000	128	54
2	New Granular A Base	0.14	1.00	-	-	250,000	81	11
3	New Granular B,Type I	0.09	1.00	-	-	150,000	555	50
Total	-	-	-	-	-	-	763	115

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Table B38
PAVEMENT DESIGN AND ANALYSIS - FLEXIBLE STRUCTURAL DESIGN MODULE

Durham-Scarborough Bus Rapid Transit (DS BRT)
Dundas Street East
Sections 19 and 20 - Garrard Street to Simcoe Street

Flexible Structural Design

80-kN ESALs Over Initial Performance Period	2,384,809
Initial Serviceability	4.4
Terminal Serviceability	2.4
Reliability Level (%)	90
Overall Standard Deviation	0.49
Roadbed Soil Resilient Modulus	30,000 kPa
Stage Construction	1.0
Calculated Design Structural Number	119

Specified Layer Design

Layer	Material Description	Struct Coef. (Ai)	Drain Coef. (Mi)	Thickness (Di) (mm)	Required Thickness (mm)	Calculated SN (mm)
1	New Hot Mix Asphalt	0.42	1.00	160	160	67
2	New Granular A Base	0.14	1.00	250	250	35
3	New Granular B,Type I	0.09	1.00	300	300	27
Total	-	-	-	710	710	129

Layered Thickness Design

Thickness precision

Layer	Material Description	Struct Coef. (Ai)	Drain Coef. (Mi)	Actual Spec Thickness (Di) (mm)	Actual Min Thickness (Di) (mm)	Elastic Modulus (kPa)	Calculated Thickness (mm)	Calculated SN (mm)
1	New Hot Mix Asphalt	0.42	1.00	-	-	2,750,000	134	56
2	New Granular A Base	0.14	1.00	-	-	250,000	84	12
3	New Granular B,Type I	0.09	1.00	-	-	150,000	574	52
Total	-	-	-	-	-	-	792	120

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Designed by: GBG
Checked by: _____