PARKWAY INFRASTRUCTURE CONSTRUCTORS
Nov 28, 2012
PROCESSED
PROJECT DOCUMENT AND DATA MANAGEMENT

The Windsor-Essex Parkway Project

From Bridge B-1 East Abutment Sta.Windsor 10+030 to North Talbot Road Sta.Tecumseh 12+577 WBL and Sta.Tecumseh 12+370 EBL

Approx. Length 11.2 km

Pavement Selection Final Report

Revision History					
Revision	Date	Status	Prepared By	Checked By	Reviewed By
0	06/03/11	Draft	HS	JD	YH
1	07/26/11	Draft Final	HS	JD	YH
2	08/18/11	Final	HS	JD	YH
3	10/26/11	Final	HS	JD	YH
4	11/29/11	Final	HS	JD	YH
5	06/28/12	Final	HS	JD	YH
6	07/03/12	Final	HS	JD	YH
7	07/16/12	Final	HS	JD	YH
8	11/21/12	Final	HS	JD	YH

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1 Key Maps

UNITED STATES
CANADA
Sandwich Street
Prince Road
Huron Church Road
E C Row Expressway
Grand Marais Road
Cabana Road
Dougall Parkway
North Talbot Road
Highway 401
Highway 3
Road
Cousineau
Howard Avenue
Todd Lane
Malden Road
Matchette Road
Ojibway Parkway
Detroit River

Detroit
Michigan Avenue
Wyandotte Street
Ouellette Avenue
Howard Avenue
Tecumseh Road
Walker Road
E.C. Row Expressway
Huron Church Road
Windsor
Sandwich Street
Prince Road
Division Road
Provincial Road
Dougall Avenue
Grand Marais Road
Dougall Parkway
North Talbot Road
Cabana Road
Highway 3
Cousineau Road
Highway 401
Tecumseh
LaSalle
Todd Lane
Malden Road
Ojibway Parkway
Sprucewood Avenue
Fort Street
ZUG ISLAND
Crossing X10B is the preferred crossing location.
Plaza B1 is preferred for the Canadian Plaza.
The Windsor-Essex Parkway has been identified as the Technically and Environmentally Preferred Alternative (TEPA) Access Road.

2 Executive Summary

AMEC Environment & Infrastructure, a Division of AMEC Americas Limited (AMEC), was retained by HATCH MOTT MACDONALD (HMM), to contribute in the Windsor Essex Mobility Group.

The Windsor-Essex Parkway (WEP) will connect Highway 401 to a new international crossing over the Detroit River to Interstate 75 in Michigan, USA. The WEP will be a six-lane highway, 11.2 kilometres long with 11 tunnels and a four-lane service road. Other components of the project include community and environmental features, such as 300 acres of green space, 20 kilometres of recreational trails, extensive landscaping throughout the corridor, and noise and environmental impact mitigation measures.

No geotechnical investigation was conducted specifically for this Pavement Selection Report. Information was provided by others as design referenced documents, and was used for traffic data and sub-surface conditions as follows:

- Golder Associates Report #05-1140-003-1, “Pavement Engineering for Planning Report Area of Continued Analysis Detroit River International Crossing Windsor, Ontario”, March 2008.
- URS Report for W.O. 04-33-002, “The Windsor-Essex Parkway Preliminary Design Report, Detroit River International Crossing Study, City of Windsor, County of Essex, Town of LaSalle, Town of Tecumseh”, November 2009.
- Golder Associates Report #07-1130-207-0-R01, Geocres No. 40J6-27, “Windsor-Essex Parkway Geotechnical Data Report”, June 2009.
- Golder Associates Report #07-1130-207-0-R02/05-1140-003, Geocres No. 40J6-28, “Windsor-Essex Parkway Sub-surface Conditions Baseline Report”, June 2009.
- Windsor Essex Mobility Group (WEMG), Excerpt from a Draft Report “Justification of ESALs for Pavement Engineering”, June 2012 (Appendix A).

Flexible pavement structural design was determined using the 1993 AASHTO Guide for the Design of flexible Pavement Structures (Darwin Software Program). Also, the AASHTO method of design was used for the Municipal Roads as well as the Municipal Standards as minimum design requirements, with available traffic volumes. However, for the roadways with no traffic data, traffic data was assumed based on the road classification and compared to the corresponding Municipal Standards of the City of Windsor, the Town of LaSalle and the Town of Tecumseh.

Rigid pavement structural design was determined using the 1993 AASHTO Guide for the Design of Rigid Pavement Structures (Darwin Software Program), and compared to the method described by the Canadian Portland Cement Association and the Pavement Design and Rehabilitation Manual (MTO).

The traffic loadings, represented in equivalent single axle loads (ESALs) were calculated cumulatively as described in the Ministry of Transportation Report "Procedures for Estimating Traffic Loads for Pavement Design, 1995". Design Parameters were selected using the MTO Adaptation and Verification of AASHTO Pavement Design Guide for Ontario Conditions, Final Report, March 2008.

Along the Eastbound and Westbound road alignment of Hwy 401, the pavement was divided into seven (7) sections by adopting worst case scenario and grouping the ESAL values from Bridge B-1 (Canadian Plaza) STA. Windsor 10+030 to STA. Tecumseh 11+577 Near Black Acre Dr. This was adopted to maintain the same pavement structure design in both bounds for Hwy 401 flexible and rigid pavements and Hwy 401 widening, although westbound had less traffic loadings (ESALS) as presented in Table 5-1, Table 5-2 and Table 5-3 in Section 5 of the Report.

Structural pavement designs have been developed for the Expressway main route (flexible and rigid design), as well as Expressway ramps, Highway 3, the E.C. Row Expressway, municipal roads, detours and trails, for the various required design periods.

Pavement rehabilitation strategies are described and preventive strategies are presented based on the MTO Guidelines for the Use of Life Cycle Cost Analysis on MTO Freeway Projects (MERO-018), 2005. The guidelines were tailored to satisfy the requirements for remaining surface life beyond the 30 years, as presented in the Project Agreement (Table 3, Schedule 15-3 of Appendix C).

Finally, recommendations and considerations for new pavement construction are discussed.

3 Introduction

AMEC Environment & Infrastructure, a Division of AMEC Americas Limited (AMEC), was retained by HATCH MOTT MACDONALD (HMM) to contribute in the Windsor Essex Mobility Group to carry out the Pavement Design for the proposed the Windsor-Essex Parkway (WEP).

The overall Project scope of work begins at the end of Highway 401 near North Talbot Road and terminates at the Bridge B-1 East Abutment adjacent to the Ojibway Parkway. This will include highway engineering (freeway, service roads, interchanges, crossing ramps); municipal roads design and roads improvements; and other related engineering tasks such as structural engineering (bridges, trail bridges, tunnels, retaining walls and culverts); geotechnical engineering (foundations, slope stability); pavement design; utilities and drainage/SWM design; mechanical engineering (pump stations, pump houses); landscaping design; traffic design; electrical, illumination, ITS and ATMS design; and environmental engineering. The purpose of this document is to provide the final pavement design for the Project.

The proposed Hwy 401 corridor extends through the City of Windsor, the Town of LaSalle, and the Town of Tecumseh, each of which has its own reference stationing. The reference stationing within the project as presented in URS Report for W.O. 04-33-002, are:

PROJECT LIMITS					
Bridge B-1 (Westerly limit)				**Hwy 3 (Easterly limit)**	
City of Windsor		**Town of LaSalle**		**Town of Tecumseh**	
STA. 10+030	STA. 14+807.918	STA. 10+000	STA. 13+848.884	STA. 10+000	STA. 12+577

3.1 Terms of Reference

<u>**Part 2 – Design and Construction Requirements**</u>

Project Agreement - Schedule 15-2 (Execution Version)

Article 2 Pavement Design Criteria

2.1 Order of Precedence

(a) The design and construction of Pavements shall be in accordance with the criteria contained in this Article and the following Reference Documents. If there is any conflict between the criteria contained in this Article and any Reference Document(s), the following shall apply in descending order of precedence for design and construction of Pavements:

(i) The criteria contained in this Article;

(ii) MTO Special Provisions as identified in this Article;

(iii) OPS;

(iv) DSM;

(v) Procedures for Estimating Traffic Loads for Pavement Design, 1995, MTO;

(vi) MTO Materials Information Report MI-183 "Adaptation and Verification of AASHTO Pavement Design Parameters for Ontario Conditions";

(vii) 1993 AASHTO Guide for the Design of Pavement Structures;

(viii) Canadian Portland Cement Association – Thickness Design for Streets and Highways, and Asphalt Institute Thickness Design – Asphalt Pavement for Highways and Street;

(ix) MTO Directive PHM-C-001 The Use of Surface Course Types on Provincial Highways;

(x) SDO-90-01, Pavement Design and Rehabilitation Manual (MTO);

(xi) SP-024 Manual for Condition Rating of Flexible Pavements and SP-026 Manual for Condition Rating of Rigid Pavements (MTO);

(xii) The Formulations to Calculate Pavement Condition Indices, September 2009, MTO; and

(xiii) American Society for Testing and Materials (ASTM) Standards.

2.2 General Requirements

(a) Project Co shall be responsible for design of all Pavements.

(b) Final travelled surfaces within the boundaries of the Lands following completion of the Initial Works shall meet the requirements specified in this Article.

(c) Design of all new Pavement structures within the boundaries of the Lands shall be in accordance with the 1993 AASHTO Guide for the Design of Pavement Structures. For concrete Pavements, both MTO's Routine Method as described in the SDO-90-01 Pavement Design and Rehabilitation Manual and the Canadian Portland Cement Association's Simplified Design Procedure shall be used in addition to the foregoing AASHTO guide. Traffic load calculations shall be carried out as described in the MTO Report "Procedures for Estimating Traffic Loads for Pavement Design, 1995". AASHTO Pavement design parameters shall be selected as described in the MTO Materials Information Report MI-183 "Adaptation and Verification of AASHTO Pavement Design Parameters for Ontario Conditions".

(d) If any Roads will be opened to public traffic prior to completing the surface course paving, the Pavement design shall ensure that the unfinished Pavement is designed to support public traffic until the surface course is placed.

(e) Multiple Pavement types shall not be permitted on any one line (e.g., Highway 3, the Freeway, and E.C. Row Expressway), with the following exceptions:

(i) Bridge Decks;

(ii) paved shoulders;

(iii) where new Pavement abuts existing pavement that is being widened, provided that the widened portion of the Pavement matches that of the existing Pavement; and

(iv) lengths between different Pavement types is not less than 2000 m.

(f) Pavement design report(s) shall be prepared and sub-mitted as part of the Design Development Submittals according to Section [20.3] of this Project Agreement.

2.3 Pavement Structures

(a) On the Expiry Date, no Pavements shall be composed of an Open Graded Friction Course or Stone Mastic Asphalt.

(b) Project Co shall be solely responsible for selecting all materials except as otherwise specified in this Article.

(c) Materials containing contaminants that may discharge into the environment and that could have an adverse affect on the natural environment (including air, land or water, and human plant or animal life) shall not be used. Granular materials shall conform to the requirements of Ontario Provincial Standards Specifications (OPSS) 1010 and Special Provision SP110S13.

(d) Concrete Pavements shall be plain jointed concrete and incorporate a minimum 100 millimetre of Open Graded Drainage Layer beneath the slabs. Concrete joints and load transfer devices shall conform to the requirements of the OPSD 500 series. Concrete shall conform to the requirements of OPSS Concrete-Materials and Production.

(e) Asphaltic concrete shall conform to the requirements of OPSS 1151 – Material Specification for Superpave and Stone Mastic Asphalt Mixtures.

(f) Grading and compaction shall conform to the requirements of OPSS 206 - Construction Specification for Grading, and OPSS 501 - Construction Specification for Compacting. Granular base and sub-base shall be according to OPSS 314.

(g) Drainage of the Pavement structure shall be constructed in accordance with the OPSD 300 series and sub-drains shall be in accordance with OPSS 405.

2.4 Recycling of Existing Pavement Materials

(a) Recycling of the existing Pavement materials shall be permitted. The portions of reclaimed materials permitted in the various Pavement materials shall be in accordance with OPSS 1010, OPSS 1151 and OPSS 1350.

2.5 Roughness and Other Ride Quality

(a) With respect to each Phase, following Phase Substantial Completion of the relevant Phase, the completed Pavements shall meet the smoothness criteria provided in OPSS 350 (Southwest Amend) for concrete Pavement, or SP 103F31 for hot mix asphalt Pavement.

Determination Of Remaining Service Life And Distribution

(Project Agreement – Schedule 15-3, Appendix C (Execution Version)

Item 2.1 Remaining Service Life

The Remaining Service Life (RSL) for the purposes of this Appendix shall be the service life that remains for each component of the Parkway Infrastructure measured in years taking into account the historic performance of Infrastructure of similar construction used under similar conditions. At the Expiry Date, the Parkway Infrastructure shall meet the performance levels noted in the Project Agreement, and the Remaining Service Life will be determined to have been achieved only if there is no need for any repairs or rehabilitation in respect of the Parkway Infrastructure at such time (other than basic routine maintenance of any component of the Parkway Infrastructure which will be required during the anticipated Remaining Service Life).

HIGHWAY RUNNING SURFACES

Item 3.1 Remaining Service Life

Calculated on a lane-km basis, the Remaining Service Life of the paved roads running surfaces at Expiry Date must exist at or above the limits defined in Table 3. The calculations include all Roadways, including Bridge Deck Wearing Surfaces.

Lane shall be deemed to have a surface. Where pavement patches (areas less than 400 m^2) exist within traffic lanes and the pavement life is not clearly discernable, then the oldest surface age at the location shall be used in the calculations.

The assessment of Remaining Service Life shall be carried out using the procedures outlined in the Schedule 24, Expiry Transition Procedure.

Table 3: Remaining Service Life – Highway Running Surfaces

Remaining Service Life (years)	Percentage of Length (Minimum Requirement)
A. Parkway Roads (Freeway travel lanes and their adjacent paved Shoulders)	
> 15	100
B. Other Parkway Paved and Unpaved Areas (other than vehicular travel lanes and immediate Shoulders)	
> 5	100
> 12	50.0

The Remaining Service Life for surfaces covered under item B in the Table 3, at any point, must not fall below a straight line interpolation between the two points noted under item B for each lane.

In addition to this Remaining Service Life condition requirement, Project Co must comply with the minimum Pavement profile for Roughness, Pavement Condition Index (PCI), Rutting and Friction at the Expiry Date as specified below:

(a) IRI <1.3 m/km for flexible pavements or IRI <1.5 m/km for rigid pavements;

(b) PCI >75;

(c) Rutting <6 mm;

(d) Friction >30

3.2 Historical Information

Historical information on construction, rehabilitation and maintenance of the Hwy 401, Hwy 3, E.C. Row Expressway and municipal roads was provided by the Ministry of Transportation (MTO) and Golder Associates Ltd. Background information on various roads is summarized in the Design Reference Document "Windsor Essex Parkway – Geotechnical Data Report", dated June 2009, No. 07-1130-207-0-R01Geocres No.40J6-27. The original road construction is summarized in Tables 3-1, 3-2 and 3-3.

Table 3-1: Pavement Thickness of Hwy 401 STA. Tecumseh 10+900 to STA. Tecumseh 11+300

Component STA. Tecumseh 10+900 to STA. Tecumseh 11+300	Westbound Lane			Eastbound lane		
	DL	PL	Shoulder	DL	PL	Shoulder
Asphalt	170	170	140	170	140	145
Concrete	280	280	-	235	230	-
Sand (fill)/ Granular Base	245	50	100	145	180	155
Granular Subbase/Sand (fill)	-	-	360	-	-	400

Table 3-2: Summary of Available Pavement Thickness Data

Pavement Section	From	To	Westbound*				Eastbound*			
			Avg. HMA	Avg. Concrete	Avg. Granular Base	Avg. Sub-base	Avg. HMA	Avg. Concrete	Avg. Granular Base	Avg. Sub-base
Hwy 3 (Talbot Rd)	10+000	21+550	340	210	-	-	275	205	-	-
Hwy 3-Shoulder	10+000	21+550	200	N/A	N/A	N/A	200	N/A	N/A	N/A
Huron Church Rd	-	-	260	270	-	-	345	290	-	-

*Average of both Driving Lane and Passing Lane.

Table 3-3: Summary of Available Pavement Thickness Data - Municipal Roads

Pavement Section	Average (mm)				Comments
	HMA	Concrete	Granular Base	Granular Subbase	
Outer Dr	20	-	380	310	
Outer Dr - Shoulder	20	-	335	405	
Howard Ave	245	260	195	180	Granular Base is above Concrete
Todd Ln	135	-	525	180	
Cabana Rd	100	-	460	140	
Pulford (East of Huron Church Rd)	-	280	630	460	
Pulford (West of Huron Church Rd)	-	230	330	660	
Bethlehem Ave	-	215	625	-	
Labelle St	105	-	455	130	170 mm HMA is under 455 mm Gran Base
Malden R	140	-	865	-	Average Values
Malden Rd - Shoulder	-	-	460	250	Average Values

4 Pavement/Geotechnical Investigations & Laboratory Testing

Fieldwork was not conducted for the preparation of this Pavement Selection Report. Information was provided by others as design reference documents that were used to supply traffic data and sub-surface conditions as follows:

- Golder Associates Report #05-1140-003-1, "Pavement Engineering for Planning Report Area of Continued Analysis Detroit River international Crossing Windsor, Ontario", March 2008.
- URS Report for W.O. 04-33-002, "The Windsor-Essex Parkway Preliminary Design Report, Detroit River International Crossing Study, City of Windsor, County of Essex, Town of LaSalle, Town of Tecumseh", November 2009.
- Golder Associates Report #07-1130-207-0-R01, Geocres No. 40J6-27, "Windsor-Essex Parkway Geotechnical Data Report", June 2009.
- Golder Associates Report #07-1130-207-0-R02/05-1140-003, Geocres No. 40J6-28, "Windsor-Essex Parkway Sub-surface Conditions Baseline Report", June 2009.
- Windsor Essex Mobility Group (WEMG), Excerpt from a Draft Report "Justification of ESALs for Pavement Engineering", June 2012 (Appendix A).

5 Pavement Selection

After reviewing the Terms of Reference, operational and maintenance requirements for the remaining life criteria, field and test data of the design reference documents, the minimum pavement structural design was determined for flexible pavement design was determined using the 1993 AASHTO Guide for the Design of flexible Pavement Structures (Darwin Software Program). The AASHTO method of design was used for the Municipal Roads with available traffic volumes. However, the roadways with no traffic data, the traffic data was assumed based on the road classification and compared to the corresponding Municipal Standards of the City of Windsor, Township of LaSalle and Township of Tecumseh.

The rigid pavement design was determined using three methods; 1993 AASHTO Guide for the Design of Rigid Pavement Structures (Darwin Software Program), and compared to the method described by the Canadian Portland Cement Association and the Pavement Design and Rehabilitation Manual (MTO).

The traffic loading represented in equivalent single axle loads (ESALs) was calculated cumulatively as described in the Ministry of Transportation Report "Procedures For Estimating Traffic Loads For Pavement Design, 1995" and presented in the Table below. The Design Parameters were as per MTO Adaptation and Verification of AASHTO Pavement Design Guide for Ontario Conditions, Final Report, March 2008.

The pavement from Bridge B-1 East Abutment to Hwy 401 Sta. Windsor 12+200 has been designed as a flexible pavement with a life cycle of 30 years; the pavement from Hwy 401 Sta. Windsor 12+200 to Hwy 3 has been designed as a rigid pavement with a life cycle of 45 years.

The design traffic data for the pavement design for this project was based on data provided in the Golder Associates Report #05-1140-003-1, "Pavement Engineering for Planning Report Area of Continued Analysis Detroit River international Crossing Windsor, Ontario", March 2008. The Windsor Essex Mobility Group (WEMG) provided supplementary traffic data for Hwy 401 ESALs in an excerpt of a Draft Report "Justification of ESALs for Pavement Engineering", June 2012 (Appendix A).

For urban principal arterial/freeway, the combined truck factors (CTF) as per the design Reference Documents "Procedures for Estimating Traffic Loads for Pavement Design, 1995" was calculated = 1.625. However, in the AASHTO design Reference Document: "MTO Adaptation and Verification of AASHTO Pavement Design Guide for Ontario Conditions, 2008" the CTF was calculated = 1.925. The CTF of 1.925 was used in the ESALs calculations for Hwy 401 EB and WB. The CTF details are provided in Document No. 285380-04-126-0074.

Further in the ESALs analysis, the worst case traffic loading scenario of the EBL was adopted to maintain the same pavement structure design for both EB and WB. A revised higher CTF of 2.015 was used specifically for Hwy 401 in accordance with Table 3 and 6 of design Reference Document "Procedures for Estimating Traffic Loads for Pavement Design, 1995".

Paved shoulders for the entire project will comprise two lifts of hot mix. The lift thicknesses will be similar to the adjacent surface and upper binder courses. A full asphalt thickness and granular thickness should be extended, in any areas where tracking onto a paved shoulder is considered likely, such as the inner loops of interchange ramps.

Geotextile should be installed under the entire pavement structure for the mainline (Hwy 401), Hwy 3, Ramps and E.C. Row Expressway where granular base is placed directly on fined grained subgrade soils. This is intended to provide separation and will not provide reinforcement or improvement to the subgrade.

Along the Eastbound and Westbound road alignment of Hwy 401, the pavement was divided into seven (7) sections by adopting worst case scenario and grouping the ESAL values from Bridge B-1 (Canadian Plaza) STA. Windsor 10+030 to STA. Tecumseh 11+577 Near Black Acre Dr. This was adopted to maintain the same pavement structure design in both bounds for Hwy 401 flexible and rigid pavements and for Hwy 401 widening, although westbound had less traffic loadings (ESALS) as presented in Table 5-1, Table 5-2 and Table 5-3.

One (1) section was for Hwy 401 widening from STA. Tecumseh 12+577 Near Black Acre Dr to STA. Tecumseh 12+370 EB at East of north Talbot Rd (EB limit of widening) and STA. Tecumseh 12+577 WB at West of Dougall Pkwy N/E Ramp (WB limit of widening).

The following stations represent the limits of the new construction and widening of Hwy 401 for rigid and flexible pavement:

1. Flexible (Asphalt) Pavement: STA. Windsor 10+030 to STA. Windsor 12+200 (New Construction) Table 5-1 Eastbound and Westbound.
2. Rigid (Concrete) Pavement: STA. Windsor 12+200 to STA. Tecumseh 11+577 (New Construction) Table 5-2 Eastbound and Westbound.
3. Flexible (Asphalt) Pavement: STA. Tecumseh 11+577 to STA. Tecumseh 12+370 EBL / STA. Tecumseh 12+577 WBL (Widening).

   Table 5-3 Eastbound and Westbound.

Table 5-1: Freeway (Hwy 401) Flexible Pavement Sections and ESALs for EBL / WBL

Section	Station # From	Station # To	Length (m)	AADT[1] 2015	2015 % Comm	Growth Rate (%)	LDF	Design Period	TF	ESALs for 30 yrs
1	**STA. Windsor 10+030 to STA. EB/WB**	**STA. Windsor 12+200 EB/WB** Huron Church Rd	2,170 m	17,980	52.00%[1]	1.49%	0.8	30	1.925	191,725,246 (EB)
				9,987	57.90%[1]	1.97%	0.8	30	1.925	125,363,529 (WB)
				17,980	46.46%[2]	2.00%	0.77	30	2.015	**194,158,974 (EB)[3]**

The worst case traffic loading scenario of ESALs in the EBL was adopted to maintain the same pavement structure design for both EB and WB. A revised higher CTF of 2.015 was used specifically for Hwy 401 in accordance with Table 3 and 6 of design Reference Document "Procedures for Estimating Traffic Loads for Pavement Design, 1995".

Note:

[1] Golder Associates Report #05-1140-003-1, "Pavement Engineering for Planning Report Area of Continued Analysis Detroit River international Crossing Windsor, Ontario", March 2008.

[2,3] ESALs and % Commercial Vehicles as per WEMG, Excerpt from a Draft Report "Justification of ESALs for Pavement Engineering", June 2012 (Appendix A).

Table 5-2: Freeway (Hwy 401) Rigid Pavement Sections and ESALs for EBL / WBL

Section	Station # From	Station # To	Length (m)	AADT[1] 2015	2015 % Comm	Growth Rate (%)	LDF	Design Period	TF	Adopted ESALs for 45 yrs
1	STA. Windsor 12+200 EB/WB (cut) At Retaining Wall RWD1	STA. Windsor 13+550 EB/WB Huron Church Rd	2,000 m	14,333 20,784	51.30%[1] 25.20%[1]	2.25% 1.71%	0.8 0.8	45 45	1.925 1.925	278,049,269 (EB) 182,321,266 (WB)
	STA. Windsor 13+550 EB/WB Huron Church Rd	STA. Windsor 14+200 EB/WB Pulford St		14,333	45.83%[2]	2.20%	0.75	45	2.015	314,016,012 (EB)[3]
2	STA. Windsor 14+200 EB/WB Pulford St	STA. Windsor 14+450 EB/WB Todd Ln	2,060 m	22166 9,858	27.30%[1] 29.50%[1]	1.52% 2.45%	0.8 0.8	45 45	1.925 1.925	204,250,020 (EB) 113,207,591 (WB)
	STA. Windsor 14+450 EB/WB Todd Ln	STA. LaSalle 11+450 EB /WB St. Clair College		22,166	24.39%[2]	2.00%	0.75	45	2.015	229,952,235 (EB)[3]
3	STA. LaSalle 11+450 EB/WB St. Clair College	STA. LaSalle 13+400 EB/WB Howard Ave	1,950 m	22,874 14,993	34.90%[1] 27.60%[1]	1.28% 1.99%	0.8 0.8	45 45	1.925 1.925	258,789,196 (EB) 150,495,045 (WB)
				22,874	31.18%[2]	1.90%	0.75	45	2.015	314,016,012 (EB)[3]
4	STA. LaSalle 13+400 EB/WB Howard Ave	STA. Tecumseh 10+100 EB/WB Hwy 3/ Hwy 401	550 m	27,843 14,215	36.30%[1] 27.60%[1]	0.96% 2.08%	0.8 0.8	45 45	1.925 1.925	309,645,386 (EB) 144,650,655 (WB)
				27,843	32.43%[2]	1.40%	0.75	45	2.015	314,016,012 (EB)[3]
5	STA. Tecumseh 10+100 EB/WB Hwy 3/ Hwy 401	STA. Tecumseh 10+800 EB/WB Hwy 3/ Hwy 401	700 m	18,004 5,337	35.50%[1] 44.10%[1]	1.40% 4.17%	0.8 0.8	45 45	1.925 1.925	211,461,447 (EB) 114,149,658 (WB)
				18,004	31.72%[2]	2.00%	0.75	45	2.015	246,231,236 (EB)[3]
6	STA. Tecumseh 10+800 EB/WB Hwy 3/ Hwy 401	STA. Tecumseh 11+577 EB/WB Near Black Acre Dr	780 m	21,530 19,954	36.30%[1] 27.20%[1]	2.06% 1.87%	0.8 0.8	45 45	1.925 1.925	287,277,851 (EB) 193,764,889 (WB)
				21,530	27.20%[2]	2.10%	0.75	45	2.015	314,016,012 ((EB)[3]

The worst case traffic loading scenario of ESALs in the EBL was adopted to maintain the same pavement structure design for both EB and WB. A revised higher CTF of 2.015 was used specifically for Hwy 401 in accordance with Table 3 and 6 of design Reference Document "Procedures for Estimating Traffic Loads for Pavement Design, 1995".

Note:

[1] Golder Associates Report #05-1140-003-1, "Pavement Engineering for Planning Report Area of Continued Analysis Detroit River international Crossing Windsor, Ontario", March 2008.

[2, 3] ESALs and % Commercial Vehicles as per WEMG, Excerpt from a Draft Report "Justification of ESALs for Pavement Engineering", June 2012 (Appendix A).

Table 5-3: Freeway (Hwy 401) Pavement Widening Sections and ESALs for EBL / WBL

Section	Station # From	Station # To	Length (m)	AADT[1] 2015	2015 % Comm	Growth Rate (%)	LDF	Design Period	TF	ESALs for 30 yrs
1EB/ WB	STA. Tecumseh 11+577 EB/WB Near Black Acre Dr.	STA. Tecumseh 12+370 EB East of north Talbot Rd (EB limit of widening) STA. Tecumseh 12+577 WB At West of Dougall Pkwy N/E Ramp (WB limit of widening)	795 m EB 1,000 m WB	21,530 19,954	36.30% 27.20%	2.06% 1.87%	0.8 0.8	30 30	1.925 1.925	171,156,870 (EB) 116,340,390 (WB)

The worst case traffic loading scenario of ESALs in the EBL was adopted to maintain same pavement structure design for both EB and WB

Note:

[1] Golder Associates Report #05-1140-003-1,"Pavement Engineering for Planning Report Area of Continued Analysis Detroit River international Crossing Windsor, Ontario", March 2008.

Pavements section for the flexible pavement for Highway 3 (Service Road), 401 Ramps, E.C. Row Expressway Eastbound, and Municipal Roads together with the corresponding calculated ESALs is presented in Table 5-4, Table 5-5 and Table 5-6. Traffic data represented in average annual daily traffic (AADT) for base year of 2015 and percent of commercial in Table 5-6 was extracted from Hatch Technical memo #285380-60-126-003, titled "2015 AADT Volumes Forecast for the Municipal Roadways, Windsor Essex Parkway Project", Rev. A, dated August 3/2011. The Municipal Roads will be turned backed to the municipality one (1) year after substantial completion.

Table 5-4: ESALs for Hwy 3, Hwy 401 Ramps, E.C. Row Expressway EB, and Detours

Hwy 3 Service Road (SR)							
AADT 2015		2015 % Comm	Growth Rate (%)	LDF	Design Period	CTF	ESALs
Hwy 401	27,843	36.3%	0.96%	0.8	4	1.925	23,051,833
Hwy 3 from SR2 to SR6	25,501	1.7%	0.91%	0.8	30	1.925	8,275,004
Hwy 3 SR1	23,492	6.8%	0.83	0.8	30	1.925	30,179,877
Hwy 401 Ramps							
Ramps	1,919	18.3%	5.83%	0.8	30	1.925	10,927,974
	16,563	9.3%	0.65%	0.8	30	1.925	28,423,225
E.C. Row Expressway Eastbound							
Sect 1	29,462	5.4%	1.18%	0.8	30	1.925	31,418,454
Sect 2[1]	11,900	5.0%	1.8%	0.9	30	1.925	14,233,753
E.C. Row Ramps							
Ramps	4,100	2.0%	0.36%	1	20	1.925	1,191,714
	5,500	2.0%	0.53%	1	20	1.925	1,623,605
	2,904	3.0%	0.66%	1	20	1.925	1,301,015
Detour							
Hwy 401	27,843	36.3%	0.96%	0.8	1	1.925	5,681,150
Hwy 401	27,843	36.3%	0.96%	0.8	2	1.925	11,416,839

Description			Road Classification	Flexible Pavement Design Period
(SR1) from North of Labelle St to Grand Marais Rd STA. 10+082 to STA. 10+990, length 908 m (SR2) from Grand Marais Rd to Huron Church STA. 20+000 to STA. 21+788, length 1,788 m (SR3) from Huron Church to St Clair College STA. 030+000 to STA. 31+048, length 1,048 m (SR4) from St Clair College to Howard Ave STA. 040+000 to STA. 042+153, length 2,153 m (SR5) from St Clair College to Howard Ave STA. 010+000 to STA. 010+660, length 660 m (SR6) from South of Laurier Extension to Hwy3 - Talbot Rd (Hwy 3) STA. 010+000 to STA. 011+000, length 1,000 m			Major Arterial (Urban)	4 Yrs traffic will be diverted from Hwy 401 (23,051,833) SR1 30 Yrs ESALs = 30,179,877+ 4 yrs of Hwy 401 SR 2 through SR6 30 Yrs ESALs = 8,275,004+ 4 yrs of Hwy 401
Hwy 3 merge/split	WBR 8, WBR9, BR10	EBR10, EBR11	Major Arterial (Urban)	30 Yrs ESALs = 10,927,974 to 28,423,225
At Howard Ave	WBR7	EBR9		
At St. Clair College	WBR6	EBR7		
At Todd Ln/Cabana Rd	WBR5	EBR5, EBR6		
At Huron Church Rd	WBR4	EBR4		
At Malden Rd	--------	EBR3		
Ojibway Pkwy Interchange	WBR2, WBR1	EBR1, EBR2		
E.C. Row Expwy to Hwy 401	WBR3			
Section 1	E.C. Row Expwy EB limit of New Construction STA. 12+669 Near Huron Church Rd to Matchette Rd STA. 10+600		Major Arterial (Urban)	30 Yrs ESALs = 31,418,454
	<u>E.C. Row Ramps:</u> EB On Ramp (N\S-E) WB Off Ramp (E-N\S) WB Off Ramp (W-N\S)		Minor Arterial (Urban)	 20 Yrs ESALs = 1,191,714 20 Yrs ESALs = 1,623,605 20 Yrs ESALs = 1,301,015
Section 2	West of Matchette Rd STA. 10+610 to Ojibway Pkwy STA. 10+000		Major Arterial (Urban)	30 Yrs ESALs = 14,233,753
<u>Detours</u>			Minor	Option 1 - One Yr of Hwy 401

D-5: Hwy 3 (3 Lanes): Howard Ave to Cousineau Dr D-4: Hwy 3 (4 Lanes): Huron Church Line D-3: Huron Church / Hwy 3 (4+ Lanes): Cabana Rd to Pulford St D-2: Huron Church / Hwy 3 (4+ Lanes): Grand Marais Rd to Labelle St D-1: South Service Rd (2 Lanes): Grand Marais Rd to Labelle St DS-1: Howard Ave (2+ Lanes): STA. Tecumseh 10+000 DS-2: Cabana/Todd Lane (2+ Lanes): STA. LaSalle 10+100 DS-3: Huron Church Line DS-4: St Clair College & Cousineau Dr: St Clair STA. LaSalle (11+550) / Cousineau Dr STA. LaSalle (11+750 to 12+200)	Arterial (Urban)	traffic 5,681,150 Option 2 - Two Yrs of Hwy 401 traffic 11,416,839

Note: [1] Volumes along E.C. Row Expwy were developed using peak volumes and AADT provided by Hatch.

Table 5-5: ESALs for Municipal Roads (WB & EB Differentiated)

Municipal Roadway	From	To	Road Classification	WB/AADT[1] EB/AADT[1]	% Comm	Growth Rate	CTF	ESALs for 20 Years
Montgomery Dr (LaSalle)	Sta. 10+011 to Sta. 10+110		Urban- Local	*n/a: Assume ESALs = 300,000 (WB/EB)*			n/a	n/a
Outer Dr (Tecumseh)	Entire		Rural- Local	*n/a: Assume ESALs = 300,000 (WB/EB)*			n/a	n/a
Outer Dr Connector (Tecumseh)	Entire		Rural- Local	*n/a: Assume ESALs = 300,000 (WB/EB)*			n/a	n/a
Spring Garden Rd (Windsor)	Connection to Bethlehem Ave		Urban- Local	*n/a: Assume ESALs = 300,000 (WB/EB)*			n/a	n/a
Geraedts Dr or St Clair College (Windsor)	East of Talbot Rd		Urban- Minor Collector	3,009 9,320	1.00% 1.00%	0.66% 0.30%	0.741	155,674 466,663
Broadway St (Windsor)	Entire to the cross road's edge of pavement		Rural- Local	*n/a: Assume ESALs = 300,000 (WB/EB)*			n/a	n/a
Surrey Drive (LaSalle)	Cul-de-sac existing Rd		Rural- Local	*n/a: Assume ESALs = 300,000 (WB/EB)*			n/a	n/a
Homestead Ln (LaSalle)	Cul-de-sac existing Rd		Urban- Local	*n/a: Assume ESALs = 300,000 (WB/EB)*			n/a	n/a
Beech St.(Windsor)	Cul-de-sac existing Rd		Rural- Local	357 461	1.90% 1.70%	0.00% 0.00%	0.780	34,760 40,161
New Rd (Cul-de-sac off Huron Church) (LaSalle)	Entire		Urban- Local	*n/a: Assume ESALs = 300,000 (WB/EB)*			n/a	n/a
Grosvenor Dr (LaSalle)	North leg of intersection to be closed off		Rural- Local	*n/a: Assume ESALs = 300,000 (WB/EB)*			n/a	n/a
Labelle Street/	East of North Service Rd		Urban- Minor	2,903 2,203	1.00% 1.00%	0.70% 0.87%	0.741	167,475 129,016

Municipal Roadway	From	To	Road Classification	WB/AADT[1] EB/AADT[1]	% Comm	Growth Rate	CTF	ESALs for 20 Years
Bethlehem Ave (Windsor)	Bet. North and South Service Rd		Collector	1,403 3,202	1.00% 1.00%	0.58% 1.04%	0.741	80,074 190,319
	West of South Service Rd			1,804 3,255	1.00% 1.00%	0.66% 0.05%		103,702 176,909
Sandwich St (Windsor/ LaSalle)	West of Ojibway Pkwy		Rural- Major Collector	1,533 1,388	9.60% 6.60%	0.74% 0.81%	1.725	1,983,494 1,242,341
Ojibway Pkwy (Windsor)	From E.C. Row Expwy Intersection with Ojibway Pkwy Sta. 10+000 to GN Booth		Rural- Major Arterial	9,600[2] 9,600[2]	2.0% 3.0%	1.8% 1.0%	2.335	8,357,013(EB) 5,058,832(WB)
	Sandwich St	Prospect Ave	Rural- Minor Arterial	9,478 9,729	0.80% 0.80%	0.65% 0.43%	1.725	861,707 867,116
	North of Prospect Ave			9,415 9,510	0.80% 0.80%	0.66% 0.44%		856,746 848,371
	From E.C. Row Expwy intersection with Ojibway Pkwy Sta.10+000 to North of Broadway St.		Rural- Major Arterial	11,900[2] 13,300[2]	2.0% 2.0%	1.8% 1.8%	2.335	6,906,143(NB) 7,718,630(SB)
	South of Broadway St.	South Limit of Widening		13,300[2] 20,000[2]	2.0% 2.0%	1.8% 1.79%		7,718,630(SB) 10,305,437(NB)
Broadway St (Windsor)	West of Ojibway Pkwy		Rural- Local	1,000[3] 1,300[3]	2.0% 2.0%	1.88% 1.77%	0.780	134,219(EB) 172,094(WB)
N Talbot Rd (Tecumseh)	Sta .9+956 to Sta. 9+964 and Sta. 10+036 to Sta 10+044		Rural- Major Collector	4,400[4] 4,600[4]	2.0% 2.0%	1.81% 1.67%	1.725	1,298,685(WB) 1,342,308(EB)
	Sta. 9+920 to Sta. 9+956 and Sta. 10+036 to Sta. 10+070							

Note: [1] AADT given in one direction: Golder Associates Report #05-1140-003-1, "Pavement Engineering for Planning Report Area of Continued Analysis Detroit River international Crossing Windsor, Ontario", March 2008.
[2] AADT volumes along Ojibway Pkwy were provided by Hatch using peak hour volumes
[3] AADT volumes along Broadway Street were developed by using peak hour volumes from the MMM traffic report
[4] AADT volumes along North Talbot Road were developed using peak hour volumes

Table 5-6: ESALs for Municipal Roads (No Direction Differentiation)

Municipal Roadway	Location	Road Classification	2015 AADT[1] Both Directions	% Comm	Growth Rate	CTF	ESALs for 20 Years
Howard Ave (Windsor/ LaSalle/ Tecumseh)	North of Hwy 3	Rural- Minor Arterial	10,900	2.0%	Assumed 3.0%	1.725	1,587,392
	South of Hwy 3		8,250	2.0%			1,201,466

Municipal Roadway	Location	Road Classification	2015 AADT[1] Both Directions	% Comm	Growth Rate	CTF	ESALs for 20 Years
Cousineau Rd (Windsor/ LaSalle)	North of Hwy 3	Urban- Major Collector	5,900	2.0%	1.8%	1.31	594,628
Sandwich West Pkwy (Windsor/ LaSalle)	South of Hwy 3	Urban- Major Collector	11,900	2.0%	1.8%	1.31	1,332,594
Huron Church Line (LaSalle)	South of Hwy 3	Urban- Minor Arterial	9,900	4.0%	1.8%	1.31	2,217,258
Cabana Rd (Windsor)	East of Huron Church Rd	Urban- Minor Arterial	10,500	2.0%	1.8%	1.31	1,058,237
Todd Ln (LaSalle)	West of Huron Church Rd		13,600	2.0%	1.8%		1,370,669
Pulford St (Windsor)	East of Huron Church Rd	Urban- Minor Collector	1,250	1.0%*	1.8%	0.741	39,589
Grand Marais Rd (Windsor)	East of Huron Church Rd	Urban- Minor Collector	4,300	1.0%*	1.8%	0.741	136,187
Lambton St (Windsor)	West of Huron Church Rd		2,300	1.0%	1.8%		72,844
Malden Road (Windsor)	North of E.C. Row Expwy	Not available Assume – Rural Minor Arterial	6,100	4.0%	1.8%	1.725	1,798,990
	South of E.C. Row Expwy		6,100	4.0%	1.8%		1,798,990
Matchette Rd - Windsor	North of E.C. Row Expwy	Rural Minor Arterial	7,050	1.0%*	1.8%	1.725	519,790
	South of E.C. Row Expwy		9,400	1.0%	1.8%		693,053
Howard Ave Connector (Tecumseh)	West of Howard Ave Diversion	Rural- Minor Arterial	9,500	4.0%	1.8%	1.725	2,801,705
South Talbot Rd (Tecumseh)	East of Howard Ave Diversion	Rural- Major Collector	3,050	4.0%	1.8%	1.725	899,495
Laurier Pkwy (LaSalle)	West of Howard Ave Diversion	Rural- Minor Arterial	2,900	4.0%	1.8%	1.725	855,257
Howard Ave Diversion (Tecumseh)	South of Howard Connector	Rural- Minor Arterial	12,100	4.0%	1.8%	1.725	3,568,488
	N of Howard Connector - to the Roundabout Sta. 10+000 to Sat 10+500[2]		5,550	7.0%	4.8%		3,561,512
Howard Ave (LaSalle/ Tecumseh)	South of South Talbot Rd	Rural- Minor Arterial	10,600	6.0%	1.8%	1.725	4,689,170

Note: [1] AADT given in two directions.

[2] AADT for Howard Avenue Diversion 2011 base year does not exist at the time of this report but the calculated the AADT at Howard Ave north of Hwy 3 is approx. 9,100. Assuming a 50/50% split between North Howard Connector and South Howard Connector, respectively, would result of approximately 4,600 AADT volumes.

Traffic data was provided by Hatch by e-mail on Nov 10/2011 for projected year of 2035 and AADT of 14,000.

* Percent of Heavy Commercial Vehicles adjusted from 0% to a minimum of 1.0%.

5.1 Windsor Essex Parkway (Hwy 401 Extension) Pavement Design

The Design Team has adopted a rigid pavement structure, designed for 45 years and a flexible pavement design for 30 years for the mainline (Hwy 401 extension).

Concrete Pavements shall be plain jointed concrete and incorporate a minimum 100 mm of Open Graded Drainage Layer (OGDL) beneath the slabs. Concrete joints and load transfer devices shall conform to the requirements of the OPSD 500 series. Concrete shall conform to the requirements of OPSS Concrete—Materials and Production.

Drainage of the Pavement structure shall be constructed in accordance with the OPSD 300 series and sub-drains shall be in accordance with OPSS 405.

The subgrade soils within the WEP are comprised of extensive clayey silt to silty clay stratum (generally referred to as "clay"). The interpretation of subgrade Resilient Modulus (MR) for the flexible pavement design and the Modulus of Subgrade Reaction (k) for the rigid pavement design was determined from the referenced Golder Associates sub-surface soil condition reports. For design of flexible pavements at grade and in the embankment areas a minimum MR of 30 MPa is assumed. In the cut sections the shear strength characteristics of the clay subgrade will decrease with depth and can be characterized from Good to Poor corresponding to k values of 30 MPa/m to less than 10 MPa/m. For the design of the rigid pavement in the cut sections it is assumed that all subgrade soils will be improved to achieve a minimum k value of 30 MPa/m.

Preparation of the subgrade soils to meet the minimum design assumptions for all new pavements is crucial to the performance of the pavement structure. For further discussion on subgrade improvement methodology and recommendations to achieve the pavement design subgrade parameters refer to the "Preliminary subgrade improvement options are presented in the Subgrade Improvement Options Report included in 285380-04-119-0013. Options will be further defined following review of recommendations from geogrid manufacturers and an optimized design will be specified based on engineering parameters and cost effectiveness of the pavement structure".

5.1.1 Hwy 401 Rigid Pavement Design for 45 Years

For discussion of rigid pavement sections refer to Table 5-2 for more details. The following design parameters were chosen to calculate the required concrete slab thickness for 45 years (using the base year as 2015), using the AASHTO rigid pavement design method:

- Initial serviceability, Pi = 4.5;
- Terminal serviceability, Pt = 2.6;
- 28-day mean PCC modulus of rupture = 5.0 MPa;
- 28-day mean PCC modulus of elasticity, Epcc = 30,000 MPa;
- OGDL =100 mm (Asphalt treated);

- Mean effective composite k-value at depth of 475 mm = 81, 61, 41 MPa/m (refer to paragraph and Table below);
- Reliability level, R = 90 percent;
- Overall standard of deviation, So = 0.39;
- Load transfer coefficient, J = 2.5 (dowels for new construction and 0.5 m monolithic PCC shoulder); and
- Drainage coefficient, Cd = 1.0.

Mean Effective Composite k-value:

Table 1 of the Canadian Portland Cement Association (CPCA) Engineering Bulletin – "Thickness Design for Concrete Highway and Street Pavements", describes the effect of the thickness of untreated sub-base on the modulus of subgrade reaction. However, the CPCA table is limited to a 300 mm depth of sub-base. In order to extrapolate to a depth of 475 mm which is the total depth of the granular of the mainline, a regression analysis was carried out to calculate the effective Modulus of Subgrade Reaction MPa/m for different subgrade conditions good, fair and poor as presented in Table 5-7.

Table 5-7: Effective Modulus of Subgrade Reaction for Varying Thickness of Granular Base

Subgrade k value (MPa/m)	k-values				Regression Analysis	Effective Modulus of Subgrade Reaction MPa/m
	100 mm	150 mm	225 mm	300 mm		
10 (Poor condition)	12*	15*	19*	24*	$Y^* = 0.5x^2 + 1.5x + 10.0$ $R^2 = 1.0$	**41***
20 (Fair condition)	23	26	32	38	$Y = 0.75x^2 + 1.35x + 20.75$ $R^2 = 0.99$	**61**
30 (Good condition)	34**	38**	44**	52**	$Y^{**} = x^2 + x + 32$ $R^2 = 1$	**81****
40	45	49	57	66	$Y = 1.25x^2 + 0.85x + 42.75$ $R^2 = 0.99$	**101**

*Extrapolated ** Interpolated between subgrade k-value of 20 and 40 MPa/m.

The Mean effective composite k-value projected based on the regression analysis was as follows:

Poor subgrade condition 41 MPa/m
Fair subgrade condition 61 MPa/m
Good subgrade condition 81 MPa/m

As discussed in Section 3.1 the rigid pavement is designed based on a subgrade k-value of 30 MPa/m (good subgrade condition) and based on a granular thickness of 475 mm with an effective composite modulus of subgrade reaction of 81 MPa/m.

Rigid Pavement Section 1 (STA. Windsor 12+200 to STA. Windsor 14+200) EB & WB:

$AADT_{(2015)}$ = 14,333, % Comm. Vehicles = 45.83, Growth rate = 2.20%;

Design ESAL's = 315,000,000 (45 year structural design);

Mean effective composite modulus of subgrade reaction = 81 MPa/m

Recommended rigid pavement design (designed for 45 yrs) Eastbound and Westbound:

PAVEMENT CRITERIA				
Component	Design Criteria	Compaction Requirements	Depth	Accumulated Depth
Concrete Pavement	45 Year Design		360 mm	360 mm
OGDL			100 mm	460 mm
Granular A	OPSS Form 1010	100% SPMDD	150 mm	610 mm
Granular B Type II	OPSS Form 1010	100% SPMDD	225 mm	835 mm

Rigid Pavement Section 2 (STA. Windsor 14+200 to STA. LaSalle 11+450)) EB & WB:

$AADT_{(2015)}$ = 22,166, % Comm. Vehicles = 24.39, Growth rate = 2.0%;

Design ESAL's = 230,000,000 (45 year structural design);

Mean effective composite modulus of subgrade reaction = 81 MPa/m

Recommended rigid pavement design (designed for 45 yrs) Eastbound and Westbound:

PAVEMENT CRITERIA				
Component	Design Criteria	Compaction Requirements	Depth	Accumulated Depth
Concrete Pavement	45 Years Design		345 mm	345 mm
OGDL			100 mm	445 mm
Granular A	OPSS Form 1010	100% SPMDD	150 mm	595 mm
Granular B Type II	OPSS Form 1010	100% SPMDD	225mm	820 mm

Rigid Pavement Section 3 (STA. LaSalle 11+450 to STA. LaSalle 13+400) EB & WB:

$AADT_{(2015)}$ = 22,874, % Comm. Vehicles = 31.18, Growth rate = 1.9%;

Design ESAL's = 315,000,000 (45 year structural design);

Mean effective composite modulus of subgrade reaction = 81 MPa/m

Recommended rigid pavement design (designed for 45 yrs) Eastbound and Westbound:

PAVEMENT CRITERIA				
Component	Design Criteria	Compaction Requirements	Depth	Accumulated Depth
Concrete Pavement	45 Years Design		360 mm	360 mm
OGDL			100 mm	460 mm
Granular A	OPSS Form 1010	100% SPMDD	150 mm	610 mm
Granular B Type II	OPSS Form 1010	100% SPMDD	225 mm	835 mm

<u>Rigid Pavement Section 4 (STA. LaSalle 13+400 to STA. Tecumseh 10+100) EB & WB:</u>

$AADT_{(2015)}$ = 27,843, % Comm. Vehicles = 32.43, Growth rate = 1.4%;

Design ESAL's = 315,000,000 (45 year structural design);

Mean effective composite modulus of subgrade reaction = 81 MPa/m

Recommended rigid pavement design (designed for 45 yrs) Eastbound and Westbound:

PAVEMENT CRITERIA				
Component	Design Criteria	Compaction Requirements	Depth	Accumulated Depth
Concrete Pavement	45 Years Design		360 mm	360 mm
OGDL			100 mm	460 mm
Granular A	OPSS Form 1010	100% SPMDD	150 mm	610 mm
Granular B Type II	OPSS Form 1010	100% SPMDD	225 mm	835 mm

<u>Rigid Pavement Section 5 (STA. Tecumseh 10+100 to STA. Tecumseh 10+800) EB & WB:</u>

$AADT_{(2015)}$ = 18,004, % Comm. Vehicles = 31.72, Growth rate = 2.0%;

Design ESAL's = 247,000,000 (45 year structural design);

Mean effective composite modulus of subgrade reaction = 81 MPa/m

Recommended rigid pavement design (designed for 45 yrs) Eastbound and Westbound:

PAVEMENT CRITERIA				
Component	Design Criteria	Compaction Requirements	Depth	Accumulated Depth
Concrete Pavement	45 Years Design		350 mm	350 mm
OGDL			100 mm	450 mm
Granular A	OPSS Form 1010	100% SPMDD	150 mm	600 mm
Granular B Type II	OPSS Form 1010	100% SPMDD	225 mm	825 mm

Rigid Pavement Section 6 (STA. Tecumseh 10+800 to STA. Tecumseh 11+577) EB & WB:

$AADT_{(2015)}$ = 21,530, % Comm. Vehicles = 27.2, Growth rate = 2.1%;

Design ESAL's = 315,000,000 (45 year structural design);

Mean effective composite modulus of subgrade reaction = 81 MPa/m

Recommended rigid pavement design (designed for 45 yrs) Eastbound and Westbound:

PAVEMENT CRITERIA				
Component	Design Criteria	Compaction Requirements	Depth	Accumulated Depth
Concrete Pavement	45 Years Design		360 mm	360 mm
OGDL			100 mm	460 mm
Granular A	OPSS Form 1010	100% SPMDD	150 mm	610 mm
Granular B Type II	OPSS Form 1010	100% SPMDD	225 mm	835 mm

Shoulder Design Adjacent to Rigid Pavement

The outer shoulder will be 3.0 m in width. The adjacent 0.5 m will match the construction of driving lane. The outer 2.5 m will consist of 90 mm of hot mix underlain by sufficient granular to match the excavation level of the adjacent driving lane.

The following table illustrates the hot mix type, lift thickness, and PGAC type making up the overall asphalt thickness, as well as the traffic category, in accordance with OPSS 1151.

Hwy 401 - Shoulder			
HMA			
Type	**Thickness (mm)**	**PGAC**	**Traffic Category**
SP 12.5	40 mm	58-28	E
SP 19.0 mm	50 mm	58-28	E
Total	90 mm		

5.1.2 tpHwy 401 Flexible Pavement Design for 30 years

For the following discussion of flexible pavement sections, reference should be made to Table 5-1 for additional details.

The flexible pavement will be constructed on clay fill from cut areas of the project. It is assumed that the subgrade materials will be in good condition. The Design Team has adopted a resilient modulus of 30 MPa for subgrade soils placed and compacted in the embankment area.

Along the Eastbound and Westbound alignment, the flexible pavement is one (1) section by grouping the ESAL values from Bridge B-1, STA. Windsor (10+030) to STA. Windsor (12+200) at Retaining Wall RWD1 is presented in the Table 5-1.

The following design parameters were chosen to calculate the required structural design of flexible pavement for 30 years for a base year of 2015, using the AASHTO method:

- Initial serviceability, Pi = 4.5;
- Terminal serviceability, Pt = 2.6;
- Mean subgrade resilient modulus = 30 MPa
- Reliability level, R = 95 percent;
- Overall standard of deviation, So = 0.49;
- HMA layer coefficient, ai = 0.42;
- Granular A layer coefficient, ai = 0.14;
- OGDL layer coefficient, ai = 0.14;
- Granular B Type II layer coefficient, ai = 0.14,
- Drainage coefficient for all layers, mi = 1.0

Flexible Pavement Section 1 (STA. Windsor 10+030 to STA. Windsor 12+200) EB & WB:

$AADT_{(2015)}$ = 17,980, % Comm. Vehicles = 46.46%, Growth rate = 2.0%; SN = 225 mm

Design ESAL's = 195,000,000 (30 year structural design);

Mean subgrade resilient modulus = 30 MPa

Recommended flexible pavement design (designed for 30 yrs) Eastbound and Westbound:

PAVEMENT CRITERIA				
Component	Design Criteria	Compaction Requirements	Depth	Accumulated Depth
Flexible Pavement	30 Years Design		305 mm	305 mm
OGDL			100 mm	405 mm
Granular A	OPSS Form 1010	100% SPMDD	150 mm	555 mm
Granular B Type II	OPSS Form 1010	100% SPMDD	450 mm	1,005 mm

The following table illustrates the hot mix type, lift thickness, and PGAC type making up the recommended asphalt thickness, as well as the traffic category, in accordance with OPSS 1151.

Hwy 401 - Lanes				Hwy 401 - Shoulder			
HMA		PGAC	Traffic Category	HMA		PGAC	Traffic Category
Type	Thickness (mm)			Type	Thickness (mm)		
SP 12.5 FC2	40 mm	70-28	E	SP 12.5	40 mm	58-28	E
SP 19.0 mm	50 mm	64-28	E	SP 19.0 mm	50 mm	58-28	E
SP 19.0 mm	60 mm	58-28	E				
SP 19.0 mm	75 mm	58-28	E				
SP 25.0 mm	80 mm	58-28	E				
Total	305 mm			Total	90 mm		

Shoulder Design Adjacent to Flexible Pavement

As illustrated in the preceding tables, the 3.0 m wide shoulders will consist of 90 mm of hot mix, underlain by sufficient granular to match the base of granular below the adjacent driving lane.

5.2 Flexible Pavement Design for Hwy 401 Ramps

The following design parameters were chosen to calculate the required structural design of the flexible pavement for 30 years for a base year 2015 using the AASHTO method:

- $AADT_{(2015)}$ = 1,919, % Comm. Vehicles = 18.3%, Growth rate = 5.83%;
- Design ESAL's = 11,000,000 (30 year structural design);
- $AADT_{(2015)}$ = 16, 563 % Comm. Vehicles = 9.3%, Growth rate = 0.65%;
- Design ESALs = 29,000,000 (30 year structural design);
- Initial serviceability, Pi = 4.5;
- Terminal serviceability, Pt = 2.6;
- Mean subgrade resilient modulus = 30 MPa,
- Reliability level, R = 90 percent;
- Overall standard of deviation, So = 0.49;
- HMA layer coefficient, ai = 0.42;
- Granular A layer coefficient, ai = 0.14;
- OGDL layer coefficient, ai = 0.14 (n/a)
- Granular B Type II layer coefficient, ai = 0.14;
- Drainage coefficient for all layers, mi = 1.0

ESAL's were calculated for individual westbound ramps and eastbound ramps. Generally, the maximum ESAL for each group was used to calculate the following pavement designs, with modifications to particular ramps that showed significantly higher ESAL's.

Westbound 401 Ramps – Selected ESAL for Design Period of 30 Years

Pavement Section	ESALs for 30 yrs	SN	HMA	Gran A	Gran B	Total Thickness	HMA Shoulders
Hwy 3 merge/split							
(WBR10): Hwy 401 WB Off Ramp	29,000,000	**169**	255	150	300	705	90
(WBR8): Hwy 401 WB On Ramp	11,000,000	**149**	215	150	300	665	90
(WBR9): Hwy 401 WB Off Ramp (to Hwy 3)			215	150	300	665	90
(WBR10): Hwy 401 WB Off Ramp (to Laurier split)	29,000,000	**169**	255	150	300	705	90
At Howard Avenue							
(WBR7): Hwy 401 WB On Ramp			215	150	300	665	90
At St. Clair College							
(WBR6): Hwy 401 WB Off Ramp			215	150	300	665	90
At Todd Ln/Cabana Rd							
(WBR5): Hwy 401 WB On Ramp	11,000,000	**149**	215	150	300	665	90
At Huron Church Rd							
(WBR4): Hwy 401 WB Off Ramp			215	150	300	665	90
Ojibway Pkwy Interchange							
(WBR2): Hwy 401 WB Off Ramp			215	150	300	665	90
(WBR1): Hwy 401 WB On Ramp			215	150	300	665	90
E.C. Row Expwy to Hwy 401	29,000,000						
(WBR3): Hwy 401 WB On Ramp		**169**	255	150	300	705	90

Eastbound 401 Ramps – Selected ESAL for Design Period of 30 Years

Pavement Section	ESALs for 30 yrs	SN	HMA	Gran A	Gran B	Total Thickness	HMA Shoulders
Hwy 3 merge/split							
(EBR10): Hwy 401 EB Off Ramp			215	150	300	665	90
(EBR11): Hwy 401 EB On Ramp			215	150	300	665	90
At Howard Ave							
(EBR9): Hwy 401 EB On Ramp			215	150	300	665	90
At St. Clair College	11,000,000	149					
(EBR7): Hwy 401 EB Off Ramp			215	150	300	665	90
(EBR8): Hwy 401 EB On Ramp			215	150	300	665	90
At Todd Ln/Cabana Rd							
(EBR5): Hwy 401 EB Off Ramp			215	150	300	665	90
(EBR6): Hwy 401 EB On Ramp			215	150	300	665	90
At Huron Church Rd							
(EBR4): Hwy 401 EB On Ramp	29,000,000	169	255	150	300	705	90
At Malden Rd **(EBR3):** Hwy 401 EB Off Ramp			255	150	300	705	90
Ojibway Pkwy Interchange							
(EBR1): Hwy 401 EB Off Ramp	11,000,000	149	215	150	300	665	90
(EBR2): Hwy 401 EB On Ramp			215	150	300	665	90

Flexible Pavement Design (Ramps) – 30 years for ESAL's = 11,000,000

PAVEMENT CRITERIA				
Component	Design Criteria	Compaction Requirements	Depth	Accumulated Depth
Flexible Pavement	30 Years Design		215 mm	215 mm
Granular A	OPSS Form 1010	100% SPMDD	150 mm	365 mm
Granular B Type II	OPSS Form 1010	100% SPMDD	300 mm	665 mm

The following table illustrates the hot mix type, lift thickness, and PGAC type making up the recommended asphalt thickness, as well as the traffic category, in accordance with OPSS 1151. It should be noted that the granular thickness for shoulder construction must be sufficient to match the base of the granular below the adjacent traffic lanes. However, the thickness of the shoulder for Ramps EBR1, EBR4, and EBR6 shall be equal to the total pavement thickness on the Ramp.

Hwy 401 Ramps				Hwy 401 Ramps - Shoulder			
HMA		PGAC	Traffic Category	HMA		PGAC	Traffic Category
Type	Thickness (mm)			Type	Thickness (mm)		
SP 12.5 FC2	40 mm	70-28	D	SP 12.5	40 mm	58-28	D
SP 19.0 mm	50 mm	64-28	D	SP 19.0 mm	50 mm	58-28	D
SP 19.0 mm	60 mm	58-28	D				
SP 25.0 mm	65 mm	58-28	D				
Total	215 mm			Total	90 mm		

Flexible Pavement Design (Ramps) – 30 years for ESAL's = 29,000,000

PAVEMENT CRITERIA				
Component	Design Criteria	Compaction Requirements	Depth	Accumulated Depth
Flexible Pavement	30 Years Design		255 mm	255 mm
Granular A	OPSS Form 1010	100% SPMDD	150 mm	405 mm
Granular B Type II	OPSS Form 1010	100% SPMDD	300 mm	705 mm

The following tables illustrate the hot mix type, lift thickness, and PGAC type making up the recommended asphalt thickness, as well as the traffic category, in accordance with OPSS 1151. It should be noted that the granular thickness for shoulder construction must be sufficient to match the base of the granular below the adjacent traffic lanes. However, the thickness of the shoulder for Ramps WBR1, WBR4, and WBR8 shall be equal to the total pavement thickness on the Ramp.

Hwy 401 Ramps				Hwy 401 Ramps - Shoulder			
HMA		PGAC	Traffic Category	HMA		PGAC	Traffic Category
Type	Thickness (mm)			Type	Thickness (mm)		
SP 12.5 FC2	40 mm	70-28	D	SP 12.5	40 mm	58-28	D
SP 19.0 mm	50 mm	64-28	D	SP 19.0 mm	50 mm	58-28	D
SP 19.0 mm	75 mm	58-28	D				
SP 25.0 mm	90 mm	58-28	D				
Total	255 mm			Total	90 mm		

<u>Shoulder Design Adjacent To Ramps</u>

As illustrated in the preceding tables, the shoulders will consist of 90 mm of hot mix, underlain by sufficient granular to match the base of granular below the adjacent driving lane.

5.3 Flexible Pavement Design for Hwy 3

The following design parameters were chosen to calculate the required structural design of the flexible pavement for 30 years for a base year 2015 using the AASHTO method:

- $AADT_{(2015)}$ = 25,501, % Comm. Vehicles = 1.7%, Growth rate = 0.91;
- $AADT_{(2015)}$ = 23,492, % Comm. Vehicles = 6.8%, Growth rate = 0.83;
- Design ESAL's = Please refer to the Table below for 30 years of structural design;
- SN = Please refer to the Table below for 30 years of structural design;
- Initial serviceability, Pi = 4.5;
- Terminal serviceability, Pt = 2.6;
- Mean subgrade resilient modulus = 30 MPa,
- Reliability level, R = 90 percent;
- Overall standard of deviation, So = 0.49;
- HMA layer coefficient, ai = 0.42;
- Granular A layer coefficient, ai = 0.14;
- Granular B Type II layer coefficient, ai = 0.14; and
- Drainage coefficient for all layers, mi = 1.0.
-

ESALs were calculated for each of the 6 Service Roads (SR) of Hwy 3 for 30 years. For surface roads having similar data, a representative ESAL was chosen for pavement design, as indicated in the following table. Also, Hwy 401 traffic will be diverted onto Hwy 3 during construction (for 3 to 4 years). With these considerations, the cumulative ESALs of Hwy 401 for 4 years were calculated to be 23,051,833.

ESALs for Hwy 3 Sections for 30 Years Design Period

Street Name	From Sta.	To Sta.	Length	# Lanes	Lane Width	Turn Lane Width	ESALs
Hwy 3 (SR1): From North of Labelle St to Grand Marais Rd	010+082	010+990	908	2	3.75	3.5	53,231,710
Hwy 3 (SR2): From Grand Marais Rd to Huron Church	020+000	021+788	1,788	2	3.75	3.5	31,326,837
Hwy 3 (SR3): From Huron Church to St Clair College	030+000	031+048	1,048	5	3.75	3	
Hwy 3 (SR4): From St Clair College to Howard Ave	040+000	042+153	2,153	5	3.75	3	

Street Name	From Sta.	To Sta.	Length	# Lanes	Lane Width	Turn Lane Width	ESALs
Hwy 3 (SR5): From Howard Ave to Laurier Extension	010+000	010+660	660	5	3.75	3	
Hwy 3 (SR6): South of Laurier Extension to Hwy 3 - Talbot Rd (Hwy 3)	010+000	011+000	1,000	4	3.75	3	

The selected ESALs for Hwy 3 were used to determine the design pavement thickness as shown in the table below.

Hwy 3 Pavement Design for 30 years

Hwy 3 Service Rd #	SN	HMA (mm)	Gran A (mm)	Gran B (mm)	Total Thickness (mm)	HMA Shoulders (mm)
Hwy 3 (SR1): From North of Labelle St to Grand Marais Rd	182	275	150	325	750	90
Hwy 3 (SR2): From Grand Marais Rd to Huron Church	171	250	150	325	725	90
Hwy 3 (SR3): From Huron Church to St Clair College						
Hwy 3 (SR4): From St Clair College to Howard Ave		250	150	325	725	90
Hwy 3 (SR5): From St Clair College to Howard Ave		250	150	325	725	90
Hwy 3 (SR6): South of Laurier Extension to Hwy3 - Talbot Rd (Hwy 3)						

Hwy 3 Flexible Pavement Design – 30 years for ESAL's = 53,500,000

PAVEMENT CRITERIA				
Component	Design Criteria	Compaction Requirements	Depth	Accumulated Depth
Flexible Pavement	30 Years Design		275 mm	275 mm
OGDL				
Granular A	OPSS Form 1010	100% SPMDD	150 mm	425 mm
Granular B Type II	OPSS Form 1010	100% SPMDD	325 mm	750 mm

The following table illustrates the hot mix type, lift thickness, and PGAC type making up the recommended asphalt thickness, as well as the traffic categories, in accordance with OPSS 1151. It should be noted that the granular thickness for shoulder construction must be sufficient to match the base of the granular below the adjacent traffic lanes.

Hwy 3 – Lanes (30 yrs)				Hwy 3 -Shoulders (30 yrs)			
Type	**HMA Thickness**	**Traffic Category**	**PGAC**	**Type**	**HMA Thickness**	**Traffic Category**	**PGAC**
SP 12.5 FC2	40 mm	E	70-28	SP 12.5	40 mm	E	58-28
SP 19.0 mm	50 mm	E	64-28	SP 19.0 mm	50 mm	E	58-28
SP 19.0 mm	55 mm	E	58-28				
SP 19.0 mm	60 mm	E	58-28				
SP 25.0 mm	70 mm	E	58-28				
Total	275 mm			Total	90 mm		

Hwy 3 Flexible Pavement Design – 30 years for ESAL's = 31,500,000

PAVEMENT CRITERIA				
Component	Design Criteria	Compaction Requirements	Depth	Accumulated Depth
Flexible Pavement	30 Years Design		250 mm	250 mm
OGDL				
Granular A	OPSS Form 1010	100% SPMDD	150 mm	400 mm
Granular B Type II	OPSS Form 1010	100% SPMDD	325 mm	725 mm

The following table illustrates the hot mix type, lift thickness, and PGAC type making up the recommended asphalt thickness, as well as the traffic categories, in accordance with OPSS 1151. It should be noted that the granular thickness for shoulder construction must be sufficient to match the base of the granular below the adjacent traffic lanes.

Hwy 3 – Lanes (30 yrs)				Hwy 3 -Shoulders (30 yrs)			
Type	**HMA Thickness**	**Traffic Category**	**PGAC**	**Type**	**HMA Thickness**	**Traffic Category**	**PGAC**
SP 12.5 FC2	40 mm	D	70-28	SP 12.5	40 mm	D	58-28
SP 19.0 mm	50 mm	D	64-28	SP 19.0 mm	50 mm	D	58-28
SP 19.0 mm	70 mm	D	58-28				
SP 25.0 mm	90 mm	D	58-28				
Total	250 mm			Total	90 mm		

<u>Shoulder Design Adjacent to Hwy 3</u>

As illustrated in the preceding tables the shoulders will consist of 90 mm of hot mix, underlain by sufficient granular to match the base of granular below the adjacent driving lane.

5.4 Flexible Pavement Design for E.C. Row Expressway Eastbound Lane

The eastbound alignment of the pavement for E.C. Row Expressway was divided into two (2) sections by grouping the ESAL values as presented in the Table below.

Street Name	Beginning Station	Ending Station	Length	# Lanes	Lane Width	Turn Lane Width
E.C. Row Expwy EBL	10+633	12+669	2,036	2	3.75	0

Section	E.C. Row Expwy EB (Urban Rd)	SN	Design ESALs
1	E.C. Row Expwy EB limit of New Construction STA. 12+669 Near Huron Church Rd to Matchette Rd STA. 10+600	180 mm	30 Yrs ESALs = 31,418,454
	E.C. Row Ramps: EB On Ramp (N\S-E) WB Off Ramp (E-N\S) WB Off Ramp (W-N\S)	108 mm 111 mm 114 mm	20 Yrs ESALs = 1,191,714 20 Yrs ESALs = 1,623,605 20 Yrs ESALs = 1,301,015
2	West of Matchette Rd STA. 10+610 to Ojibway Pkwy STA. 10+000	164 mm	30 Yrs ESALs = 14,233,753 (for both EB/WB)

The following design parameters were chosen to calculate the required structural design of the flexible pavement for 30 years for a base year 2015 using the AASHTO method:

- Initial serviceability, Pi = 4.5;
- Terminal serviceability, Pt = 2.6;
- Mean subgrade resilient modulus = 30 MPa
- Reliability level, R = 95 percent;
- Overall standard of deviation, So = 0.49;
- HMA layer coefficient, ai = 0.42;
- Granular A layer coefficient, ai = 0.14;
- OGDL layer coefficient, ai = 0.14 (n/a);
- Granular B Type II layer coefficient, ai = 0.14; and
- Drainage coefficient for all layers, mi = 1.0.

Flexible Pavement E.C. Row Expressway Section 1 EB (STA.12+669 to STA. 10+610)

$AADT_{(2015)}$ = 29,462, % Comm. Vehicles = 5.4%, Growth rate =1.18%; SN = 180 mm

Design ESALs = 32,000,000 (30 year structural design)

Recommended flexible pavement design for E.C. Row (designed for 30 yrs) Eastbound:

PAVEMENT CRITERIA				
Component	Design Criteria	Compaction Requirements	Depth	Accumulated Depth
Flexible Pavement	30 Years Design		240 mm	240 mm
Granular A	OPSS Form 1010	100% SPMDD	150 mm	390 mm
Granular B Type II	OPSS Form 1010	100% SPMDD	450 mm	840 mm

The following table illustrates the hot mix type, lift thickness, and PGAC type making up the recommended asphalt thickness, as well as the traffic category in accordance with OPSS 1151. It should be noted that the granular thickness for shoulder construction must be sufficient to match the base of the granular below the adjacent traffic lanes.

E.C. Row Expwy - Lanes				E.C. Row Expwy - Shoulder			
Type	**HMA Thickness (mm)**	**PGAC**	**Traffic Category**	**Type**	**HMA Thickness (mm)**	**PGAC**	**Traffic Category**
SP 12.5 FC2	40 mm	70-28	E	SP 12.5	40 mm	58-28	E
SP 19.0 mm	50 mm	64-28	E	SP 19.0 mm	50 mm	58-28	E
SP 19.0 mm	70 mm	58-28	E				
SP 25.0 mm	80 mm	58-28	E				
Total	240 mm			Total	90 mm		

Flexible Pavement E.C. Row Section 2 EB (STA. 10+610 to STA. 10+000)

$AADT_{(2015)}$ = 11,900, % Comm. Vehicles = 5.0%, Growth rate =1.8%; SN =164 mm

Design ESALs = 15,000,000 (30 year structural design);

Recommended flexible pavement design for E.C. Row (designed for 30 yrs) Eastbound:

PAVEMENT CRITERIA				
Component	Design Criteria	Compaction Requirements	Depth	Accumulated Depth
Flexible Pavement	30 Years Design		210 mm	210 mm
Granular A	OPSS Form 1010	100% SPMDD	150 mm	360 mm
Granular B Type II	OPSS Form 1010	100% SPMDD	400 mm	760 mm

The following table illustrates the hot mix type, lift thickness, and PGAC type making up the recommended asphalt thickness, as well as the traffic category in accordance with OPSS 1151. It should be noted that the granular thickness for shoulder construction must be sufficient to match the base of the granular below the adjacent traffic lanes.

E.C. Row Expwy- Lanes				**E.C. Row Expwy - Shoulder**			
Type	**HMA Thickness (mm)**	**PGAC**	**Traffic Category**	**Type**	**HMA Thickness (mm)**	**PGAC**	**Traffic Category**
SP 12.5 FC2	40 mm	70-28	D	SP 12.5	40 mm	58-28	D
SP 19.0 mm	50 mm	64-28	D	SP 19.0 mm	50 mm	58-28	D
SP 19.0 mm	60 mm	58-28	D				
SP 25.0 mm	60 mm	58-28	D				
Total	210 mm			Total	90 mm		

<u>Shoulder Design Adjacent to E.C. Row Expressway</u>

As illustrated in the preceding tables, the shoulders will consist of 90 mm of hot mix, underlain by sufficient granular to match the base of granular below the adjacent driving lane.

5.4.1 Flexible Pavement Design for E.C. Row Expressway Ramps

Traffic data represented in average annual daily traffic (AADT) for base year of 2015 and percent of commercial was provided by Hatch on August 5/2011. The ramps were designed for a period of 20 years for a based year 2015.

E.C. Row Expwy Ramps In Section 1	**Road Classification**	**AADT 2015 Both Directions**	**% Comm Veh**	**Growth Rate (%)**
EB On Ramp N\S-E	Urban	4,100	2.00%	0.36%
WB Off Ramp E-N\S	Urban	5,500	2.00%	0.53%
WB Off Ramp W-N\S	Urban	2,904	3.00%	0.66%

The following design parameters were chosen to calculate the required structural design of the flexible pavement for 20 years for a base year 2015 using the AASHTO method:

- Initial serviceability, Pi = 4.5;
- Terminal serviceability, Pt = 2.5;
- Mean subgrade resilient modulus = 30 MPa 100
- Reliability level, R = 90 percent;
- Overall standard of deviation, So = 0.49;
- HMA layer coefficient, ai = 0.42;
- Granular A layer coefficient, ai = 0.14;
- Granular B Type II layer coefficient, ai = 0.14; and
- Drainage coefficient for all layers, mi = 1.0.

E.C. Row Ramps Section 1	**ESALs for 20 yrs**	**SN**	**HMA**	**Gran A**	**Gran B**	**Total Thickness**	**HMA Shoulders**
EB On Ramp (N\S-E)	1,200,000	108	140	150	250	540	90
WB Off Ramp (W-N\S)	1,400,000	111	140	150	250	540	90
WB Off Ramp (E-N\S)	1,700,000	114	145	150	250	545	90

Recommended flexible pavement design for E.C. Row EB on Ramp (N\S-E) and WB off Ramp (W-N\S)

PAVEMENT CRITERIA				
Component	Design Criteria	Compaction Requirements	Depth	Accumulated Depth
Flexible Pavement	20 Years Design		140 mm	140 mm
Granular A	OPSS Form 1010	100% SPMDD	150 mm	290 mm
Granular B Type II	OPSS Form 1010	100% SPMDD	250 mm	540 mm

The following table illustrates the hot mix type, lift thickness, and PGAC type making up the recommended asphalt thickness, as well as the traffic category, in accordance with OPSS 1151. It should be noted that the granular thickness for shoulder construction must be sufficient to match the base of the granular below the adjacent traffic lanes.

E.C. ROW Ramps				E.C. ROW Ramps - Shoulder			
HMA				**HMA**			
Type	**Thickness (mm)**	**PGAC**	**Traffic Category**	**Type**	**Thickness (mm)**	**PGAC**	**Traffic Category**
SP 12.5 FC2	40 mm	70-28	B	SP 12.5	40 mm	58-28	B
SP 19.0 mm	50 mm	64-28	B	SP 19.0 mm	50 mm	58-28	B
SP 19.0 mm	50 mm	58-28	B				
Total	140 mm			Total	90 mm		

Recommended flexible pavement design for E.C. Row WB off Ramp (E-N\S)

PAVEMENT CRITERIA				
Component	Design Criteria	Compaction Requirements	Depth	Accumulated Depth
Flexible Pavement	20 Years Design		145 mm	145 mm
Granular A	OPSS Form 1010	100% SPMDD	150 mm	295 mm
Granular B Type II	OPSS Form 1010	100% SPMDD	250 mm	545 mm

The following table illustrates the hot mix type, lift thickness, and PGAC type making up the recommended asphalt thickness, as well as the traffic category, in accordance with OPSS 1151. It should be noted that the granular thickness for shoulder construction must be sufficient to match the base of the granular below the adjacent traffic lanes.

E.C. ROW Ramps				E.C. ROW Ramps - Shoulder			
HMA				**HMA**			
Type	**Thickness (mm)**	**PGAC**	**Traffic Category**	**Type**	**Thickness (mm)**	**PGAC**	**Traffic Category**
SP 12.5 FC2	40 mm	70-28	B	SP 12.5	40 mm	58-28	B
SP 19.0 mm	50 mm	64-28	B	SP 19.0 mm	50 mm	58-28	B
SP 19.0 mm	55 mm	58-28	B				
Total	145 mm			Total	90 mm		

Shoulder Design Adjacent To Ramps

As illustrated in the preceding tables, the shoulders will consist of 90 mm of hot mix, underlain by sufficient granular to match the base of granular below the adjacent driving lane.

5.4.2 Flexible Pavement Design for E.C. Row Expressway Widening WBL

No geotechnical or pavement composition information was available during the preparation of the widening design of E.C. Row westbound lane STA. Windsor 11+240 to STA. Windsor 11+608.

The historical information of 1968 construction was reviewed from the Ministry of Transportation Library, Proposed E.C. Row Expressway, Highway 18 to Dominion Blvd., Windsor, Ontario, (GEOCRES 40J06-03), Proposed E.C. Row Expressway from Hwy 3B to Hwy 2, Windsor Ontario (GEOCRES 40J06-04) and Design Reference Document of Golder Associates Ltd. "Windsor Essex Parkway – Subsurface Conditions Baseline Report", dated June 2009, No. 07-1130-207-0-R02Geocres No.40J6-28.

The traffic data was extracted from Golder Associates Report #05-1140-003-1, "Pavement Engineering for Planning Report Area of Continued Analysis Detroit River International Crossing Windsor, Ontario", March 2008 for E.C.Row at Malden Rd.

The following design parameters were chosen to calculate the required structural design of flexible pavement for 30 years for a base year of 2015, using the AASHTO method:

- Initial serviceability, Pi = 4.5;
- Terminal serviceability, Pt = 2.6;
- Mean subgrade resilient modulus = 30 MPa
- Reliability level, R = 95 percent;
- Overall standard of deviation, So = 0.49;
- HMA layer coefficient, ai = 0.42;
- Granular A layer coefficient, ai = 0.14;
- Granular B Type II layer coefficient, ai = 0.14; and
- Drainage coefficient for all layers, mi = 1.0
- E.C. Row Expressway WBL Widening (STA. Windsor 11+240 to STA. Windsor 11+608)
- $AADT_{(2015)}$ = 23,638, % Comm. Vehicles = 4.8, Growth rate = 2.01%; SN = 173 mm
- Design ESAL's = 23,000,000 (30 year structural design); and
- Mean subgrade resilient modulus = 30 MPa.

Recommended flexible pavement design for Widening E.C. Row (designed for 30 yrs):

PAVEMENT CRITERIA				
Component	Design Criteria	Compaction Requirements	Depth	Accumulated Depth
Flexible Pavement	30 Years Design		220 mm	220 mm
Granular A	OPSS Form 1010	100% SPMDD	150 mm	370 mm
Granular B Type II	OPSS Form 1010	100% SPMDD	450 mm	820 mm

Rehabilitation of the existing segment of E.C. Row adjacent to the proposed widening is beyond the scope of work as per the PA Execution Version. Therefore, the pavement vertical profile will not be raised. It is recommended that widening start from the edge of pavement.

The following table illustrates the hot mix type, lift thickness, and PGAC type making up the recommended asphalt thickness, as well as the traffic category, in accordance with OPSS 1151.

E.C. ROW – Widening WB				**E.C. ROW – Shoulder WB**			
HMA				**HMA**			
Type	**Thickness (mm)**	**PGAC**	**Traffic Category**	**Type**	**Thickness (mm)**	**PGAC**	**Traffic Category**
SP 12.5 FC2	40 mm	70-28	D	SP 12.5	40 mm	58-28	D
SP 19.0 mm	50 mm	64-28	D	SP 19.0 mm	50 mm	58-28	D
SP 19.0 mm	60 mm	58-28	D				
SP 25.0 mm	70 mm	58-28	D				
Total	220 mm			Total	90 mm		

Shoulder Design Adjacent To Flexible Pavement

As illustrated in the preceding tables, the shoulders will consist of 90 mm of hot mix, underlain by sufficient granular to match the base of granular below the adjacent driving lane.

5.4.3 Flexible Pavement Design for E.C. Row Expressway for Full Depth Reconstruction Westbound (30 years)

No geotechnical or pavement composition information was available during the preparation of the full depth reconstruction design of E.C. Row westbound lane STA. Windsor 10+000 to STA. Windsor 11+400. Traffic data was provided by Hatch by e-mail dated October 10/2012.

$AADT_{(2015)}$ = 11,900, % Comm. Vehicles = 5.0%, Growth rate =1.8%; SN =164 mm

Design ESALs = 15,000,000 (30 year structural design); SN =164

Recommended flexible pavement design for Depth Reconstruction Westbound of E.C. Row:

PAVEMENT CRITERIA				
Component	Design Criteria	Compaction Requirements	Depth	Accumulated Depth
Flexible Pavement	30 Years Design		210 mm	210 mm
Granular A	OPSS Form 1010	100% SPMDD	150 mm	360 mm
Granular B Type II	OPSS Form 1010	100% SPMDD	400 mm	760 mm

The following table illustrates the hot mix type, lift thickness, and PGAC type making up the recommended asphalt thickness, as well as the traffic category in accordance with OPSS 1151. It should be noted that the granular thickness for shoulder construction must be sufficient to match the base of the granular below the adjacent traffic lanes.

E.C. Row Expwy- Lanes				**E.C. Row Expwy - Shoulder**			
Type	**HMA Thickness (mm)**	**PGAC**	**Traffic Category**	**Type**	**HMA Thickness (mm)**	**PGAC**	**Traffic Category**
SP 12.5 FC2	40 mm	70-28	D	SP 12.5	40 mm	58-28	D
SP 19.0 mm	50 mm	64-28	D	SP 19.0 mm	50 mm	58-28	D
SP 19.0 mm	60 mm	58-28	D				
SP 25.0 mm	60 mm	58-28	D				
Total	210 mm			Total	90 mm		

Shoulder Design Adjacent to E.C. Row Expressway

As illustrated in the preceding tables, the shoulders will consist of 90 mm of hot mix, underlain by sufficient granular to match the base of granular below the adjacent driving lane.

5.5 Flexible Pavement for Hwy 401 Widening EBL and WBL

No traffic data or geotechnical information were available during the preparation of the widening design of Highway 401 for eastbound lane STA. Tecumseh 11+577 to STA. Tecumseh 12+370 and westbound lane STA. Tecumseh 11+577 to STA. Tecumseh 12+577. Consequently, the historical information of construction, rehabilitation and maintenance from Golder Associates Ltd. Design Reference Document "Windsor Essex Parkway – Geotechnical Data Report", dated June 2009, No. 07-1130-207-0-R01Geocres No.40J6-27 was used for the pavement composition. This information is presented in Table 5-3 of the Report.

The traffic data was assumed to be similar to the nearest adjacent section in eastbound STA. Tecumseh 10+800 to STA. Tecumseh 11+577 and similar in the westbound STA. Tecumseh 11+577 to STA. Tecumseh 11+000. The calculated ESALs are summarized in Table 5-3 of the Report.

The following design parameters were chosen to calculate the required structural design of flexible pavement for 30 years for a base year of 2015, using the AASHTO method:

- Initial serviceability, Pi = 4.5;
- Terminal serviceability, Pt = 2.6;
- Mean subgrade resilient modulus = 30 MPa
- Reliability level, R = 95 percent;
- Overall standard of deviation, So = 0.49;
- HMA layer coefficient, ai = 0.42;
- Granular A layer coefficient, ai = 0.14;
- OGDL layer coefficient, ai = 0.14;
- Granular B Type II layer coefficient, ai = 0.14; and
- Drainage coefficient for all layers, mi = 1.0.

Hwy 401 EBL and WBL Widening (STA. Tecumseh 11+577 to STA. Tecumseh 12+370) EB and (STA. Tecumseh 11+577 to STA. Tecumseh 12+577) WB:

$AADT_{(2015)}$ = 21,530, % Comm. Vehicles = 36.3, Growth rate = 2.06%; SN = 221 mm

Design ESAL's = 172,000,000 (30 year structural design);

Mean subgrade resilient modulus = 30 MPa

Recommended flexible pavement design for widening (designed for 30 yrs) Eastbound and Westbound:

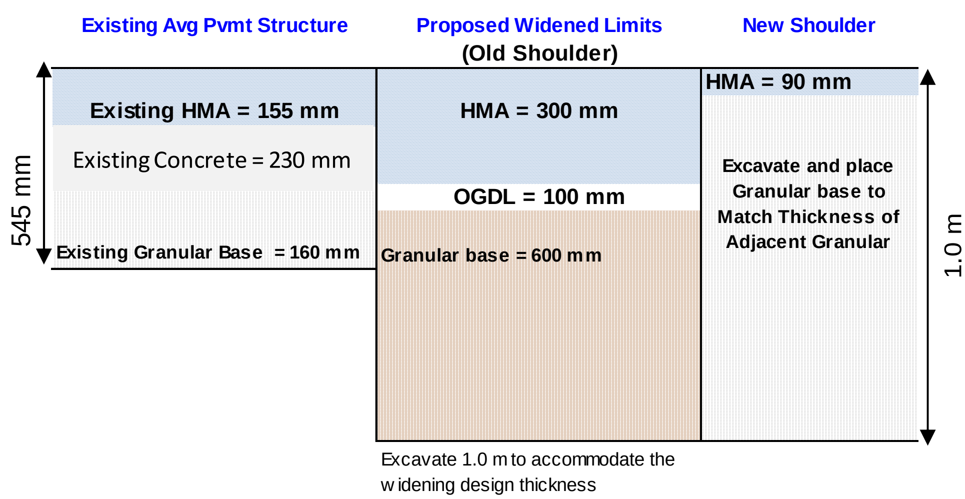
PAVEMENT CRITERIA				
Component	Design Criteria	Compaction Requirements	Depth	Accumulated Depth
Flexible Pavement	30 Years Design		300 mm	300 mm
OGDL			100 mm	400 mm
Granular A	OPSS Form 1010	100% SPMDD	600 mm	1,000 mm

Rehabilitation of the existing segment of Hwy 401 adjacent to the proposed widening is beyond the scope of work as per the PA Execution Version. Therefore, the pavement vertical profile will not be raised. It is recommended that widening start from the edge of pavement as illustrated in the two schematics below.

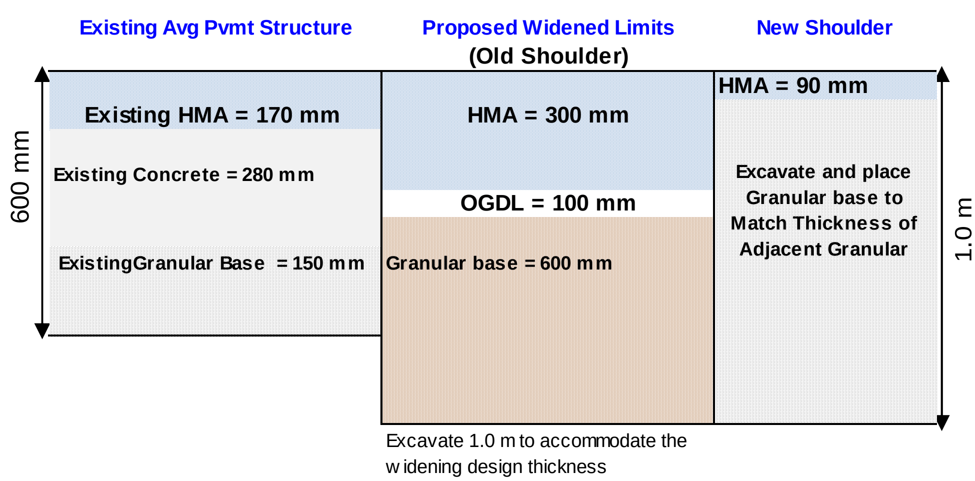
The following table illustrates the hot mix type, lift thickness, and PGAC type making up the recommended asphalt thickness, as well as the traffic category, in accordance with OPSS 1151.

Hwy 401 - Widening				Hwy 401 – Shoulder			
HMA				HMA			
Type	Thickness (mm)	PGAC	Traffic Category	Type	Thickness (mm)	PGAC	Traffic Category
SP 12.5 FC2	40 mm	70-28	E	SP 12.5	40 mm	58-28	E
SP 19.0 mm	50 mm	64-28	E	SP 19.0 mm	50 mm	58-28	E
SP 19.0 mm	60 mm	58-28	E				
SP 19.0 mm	70 mm	58-28	E				
SP 25.0 mm	80 mm	58-28	E				
Total	300 mm			Total	90 mm		

Flexible Pavement Widened Limits (New Construction - EB)
STA. Tecumseh 11+577 to STA Tecumseh 12+370 EBL



Flexible Pavement Widened Limits (New Construction - WB)
STA. Tecumseh 11+577 to STA.Tecumseh 12+577 WBL



The milled/reclaimed asphalt may be recycled and blended with granular materials to be used on the new shoulders during the new construction for widening. The use of reclaimed asphalt pavement (RAP) is not permitted in the courses of Superpave 19.0 mm, 12.5mm and 9.5 mm, within 150 mm of the pavement surface.

Granular A and Granular B Type I may contain up to 100% RCM (reclaimed concrete material) but shall not contain more than 30% by mass of asphalt coated particles and not more than a combined total of 15% by mass of glass and ceramic material. The combined amount of deleterious material shall not exceed a total of 1% by mass.

Shoulder Design Adjacent To Flexible Pavement

As illustrated in the preceding tables, the shoulders will consist of 90 mm of hot mix, underlain by sufficient granular to match the base of granular below the adjacent driving lane.

5.6 Rehabilitation Strategies for Municipal Roads

The following four (4) selected rehabilitation strategies were considered for pavement rehabilitation of municipal roads, considering minimum user delay, cost and/or disruption of traffic. The fifth option is new construction. Consideration was also given to the visual condition assessment of the roads of Golder Associates Report #05-1140-003-1, dated March 2008 and calculated ESALs.

1. Resurfacing (R) i.e. Partial Depth Removal of the Hot Mix
2. Widening (W)
3. Resurfacing and Widening (RW)
4. Full Depth Reconstruction (FDR)
5. New Construction (NC)

Option 1 - Resurfacing (Mill and Overlay): It involves cold milling the existing asphalt surface to a depth as indicated in Table 5-8 (refer to column Rehabilitation Strategy) and shall be replaced with lift(s) of new hot mix. The milled surface shall be tack coated and shall conform to OPSS 1103, Type SS1. The advantages of this option (mill/overlay) include: a lower initial cost, traffic can travel on the milled surface (little traffic impact), and minimizing the grade increase of the roadway. However, it will not prevent reflection cracking from occurring if the underlying asphalt concrete layers are not sound. Localized full depth base repairs will only be required in areas of significant structural deterioration.

Option 2 - Widening: Full depth excavation removal of the pavement commencing from the existing edge of pavement will be required where existing shoulder granular does not meet MTO specification or provide the required structural strength. Where the existing pavement structure depth on the shoulder exceeds the minimum required pavement structure design depth for pavement widening, the design granular subbase depth should be increased to match the existing subgrade and provide positive lateral drainage. Where lateral drainage of the existing subgrade cannot be accommodated, installation of subdrain will be or have to be considered. To avoid having pavement joints running diagonally through the lane of the widened portions of roadway it is recommended to mill the existing surface course, from the centerline of the existing pavement laterally towards the widened side of the roadway, then paving of the surface course commencing at centreline and extending across the existing and widened road platform width.

Option 3 - Resurfacing and Widening: It involves combination of Option 1 and Option 2 strategies.

Option 4 – Full Depth Reconstruction: Reconstruction is considered to be the extreme rehabilitation which consists of full depth removal of the entire pavement structure to the subgrade, reworking and recompaction of the subgrade, and complete replacement of the pavement layers with new materials.

5.6.1 Flexible Pavement Design for Municipal Roads

Site specific investigations have not been carried out to determine accurate subgrade conditions. The pavement design thicknesses are based on the assumption that the in-situ subgrade will be improved to achieve a minimum subgrade resilient modulus of 30 MPa.

The AASHTO method of design was used for the Municipal Roads with available traffic volumes. However, for the roadways with no traffic data, the traffic data was assumed based on the road classification and compared to the corresponding Municipal Standards of the City of Windsor, Town of LaSalle, Town of Tecumseh and County of Essex.

The following Table presents the Municipal Road names and description for the Windsor Essex Parkway project.

Street Name	Beginning Station	Ending Station	Length	# Lanes	Lane Width	Turn Lane Width
Ojibway Pkwy	009+343	010+000	657	7	3.75	3.5
Broadway St			150	2	3.5	3.5
Pulford	009+790	009+916	126	2	3.75	3.5
Spring Garden Rd	010+108	010+300	192	2	3.5	0
Todd Ln	009+978	010+312	334	4	3.5	3.5
Cabana West	009+760	009+933	173	4	3.5	3
Lambton	009+961	010+130	169	3	3.5	3.25
Labelle St	009+812	010+015	203	3	3.5	3.25
Grand Marais Rd West	009+789	009+926	137	3	3.5	3.25
Bethleham Ave	010+049	010+190	141	3	3.5	3.5
Huron Church Line	009+959	010+205	246	3	3.5	3.25
Geraedts Dr	009+900	010+028	128	4	3.5	3.25
Cousineau Rd	009+830	010+175	345	4	3.5	3.5
Montgomery Dr	010+000	010+110	110	2	3.5	0
Howard Ave	009+705	010+140	435	4	3.5	3
Howard Ave Connector	009+756	010+000	244	2	3.7	0
Howard Ave Diversion	010+000	011+120	1120	4	3.7	3.25
Outer Dr Connector	009+689	010+000	311	2	3.5	0
Outer Dr	009+674	010+142	468	2	3.5	0

The following design parameters were chosen to calculate the required structural design of the flexible pavement of Municipal Roadways for 20 years for a base year 2015 using the AASHTO method:

	Major Collector and Minor Arterial	**Local Roads and Minor Collector**
• $AADT_{(2015)}$, % Comm. Vehicles, Growth rate	• Refer to Tables 5-5, 5-6	• Refer to Tables 5-5, 5-6
• Design ESAL's = (20 year structural design);	• Refer to Tables 5-5, 5-6	• Refer to Tables 5-5, 5-6
• Initial serviceability, P_i	• 4.5	• 4.4
• Terminal serviceability, P_t	• 2.5	• 2.2
• Mean subgrade resilient modulus Mr,	• 30 MPa	• 30 MPa
• Reliability level, R;	• 90%	• 90%
• Overall standard of deviation, S_o ;	• 0.49	• 0.49
• HMA layer coefficient, a_i ;	• 0.42	• 0.42
• Granular A layer coefficient, a_i ;	• 0.14	• 0.14
• Granular B Type II layer coefficient, a_i ;	• 0.14	• 0.14
• Drainage coefficient for all layers, m_i	• 1.0	• 1.0

Table 5-8 summarizes various sections of Municipal Roads designed by using both the AASHTO Method (20 or 30 year design) and Municipal Standards as minimum design requirements for the City of Windsor, Town of LaSalle and Town of and Tecumseh. The recommended pavement design for each municipal roadway is indicated in the far right column of Table 5-8 below.

The Municipal Standards of the City of Windsor, Town of LaSalle and Town of Tecumseh recommend using Marshall Mixes such as HL 3, HL 3 (HS) HL 4, HL 8, HL 8 (HS) and shall conform to the requirements of the OPSS 1150 for Material Specification for Hot Mix Asphalt.

Table 5-8 illustrates the hot mix type, lift thickness, and PGAC type making up the recommended asphalt thickness. The material specification for Marshall and Superpave hot mixes shall be in accordance with OPSS 1150 and OPSS 1151, respectively. It should be noted that the granular thickness for shoulder construction must be sufficient to match the base of the granular below the adjacent traffic lanes.

The MTO's Routine Method as described in the SDO-90-01 Pavement Design and Rehabilitation Manual 1990 was used to calculate the equivalent granular thicknesses by using layer equivalency factors for new construction as presented below.

Material	Equivalency factor
New HL	2.0
New Granular Base	1.0
New Granular Sub-base	0.67

Generally, shoulder construction is granular for rural roads and hot mix for urban roads or as indicated in Sheet 26 "Windsor-Essex Pkwy Project RFP No. 09-54-1007", Typical Cross Sections of Side Road and Intersection.

Table 5-8: Pavement Design for Municipal Roads and Rehabilitation Strategies

Municipal Roadway	From[6]	To[6]	Road Classification	Rehabilitation Strategy[3,4]	Municipal Standards (mm)				AASHTO 20 year Design (mm)					Recommended Mix Type (mm)		Recommended Pavement Design
					HMA[1]		Gran A	GBE	HMA[1]		Gran A	GBE	SN	Superpave/Marshall		
					Surface	Binder			Surface	Binder				Surface	Binder	
Montgomery Dr (LaSalle)	Sta. 10+011 to Sta. 10+110		Urban- Local	FDR	40	50	300	480	40	60	350	550	87	HL3	HL4	Municipal Standards
Outer Dr (Tecumseh)	Entire		Rural- Local	FDR	40	60	400	600								
Outer Dr Connector (Tecumseh)	Pavement stops at Sta 9+825 and continues as gravel until limit of construction		Rural- Local	FDR and NC												
Spring Garden Rd (Windsor)	Connection to Bethlehem Ave		Urban- Local	FDR and NC	40	65	450	660								
Geraedts Dr or St Clair College (Windsor)	East of Talbot Rd		Urban- Minor Collector	FDR and NC	40	65	450	660	40	70	350	570	92	HL3	HL4	
Broadway St (Windsor)	Entire to the cross rd's edge of pavement		Rural- Local	FDR	40	65	450	660	40	60	350	550	87	HL3	HL4	
Surrey Dr (LaSalle)	Cul-de-sac existing Rd		Rural- Local	FDR	40	50	300	480	40	60	350	550	87	HL3	HL4	Municipal Standards
Homestead Ln (LaSalle)	Cul-de-sac existing Rd		Urban- Local	FDR												
Beech St. (Windsor)	Cul-de-sac existing Rd		Rural- Local	FDR	40	65	450	660	40	50	250	430	64	HL3	HL4	
New Rd (Cul-de-sac off Huron Church) LaSalle)	Entire		Urban- Local	FDR	40	50	300	480	40	60	350	550	87	HL3	HL4	Municipal Standards
Grosvenor Dr (LaSalle)	North leg of intersection to be closed off		Rural- Local	FDR												
Labelle Street/Bethlehem Ave (Windsor)	East of Hwy 3 WBL		Urban- Minor Collector	FDR	40	65	450	660	40	55	300	490	81	HL3	HL4	Municipal Standards
	Hwy 3 between EBL and WBL.			FDR												
	West of Hwy 3 EBL			FDR												
Ojibway Pkwy (Windsor)	EC Row Expwy	GN Booth Sta. 10+000 to Sta. 10+209	Rural - Major Arterial	W and FDR	40	65	450	660	40	50+60 +60	475	895	153	SP12.5FC2 Category 'C'	SP 19.0 Category 'C'	AASHTO Designed for 30 Yrs
		Sta. 9+343 to Sta. 10+000		W and FDR												

Municipal Roadway	From[6]	To[6]	Road Classification	Rehabilitation Strategy[3,4]	Municipal Standards HMA[1] Surface (mm)	Municipal Standards HMA[1] Binder (mm)	Municipal Standards Gran A (mm)	Municipal Standards GBE (mm)	AASHTO 20 year Design HMA[1] Surface (mm)	AASHTO 20 year Design HMA[1] Binder (mm)	AASHTO 20 year Design Gran A (mm)	AASHTO 20 year Design GBE (mm)	AASHTO 20 year Design SN	Recommended Mix Type Superpave/Marshall Surface	Recommended Mix Type Superpave/Marshall Binder	Recommended Pavement Design
Ojibway Pkwy (Windsor)	Sandwich St	Prospect Ave	Rural- Minor Arterial	W and FDR	40	65	450	660	40	85	400	650	104	SP12.5FC2 Category 'B'	SP 25.0 Category 'B'	AASHTO
	North of Prospect Ave			W and FDR	40	65	450	660								
	From Ojibway Pkwy intersection with E.C. Row Sta. 10+000 to N of Broadway St.		Rural- Major Arterial	W and FDR	40	65	450	660	40	50+60 +60	450	870	151	SP12.5FC2 Category 'C'	SP 19.0 Category 'C'	AASHTO Designed for 30 Yrs
	South of Broadway St. to S limit of Widening			W and FDR					40	50+60 +70	475	915	157	SP12.5FC2 Category 'D'	SP 19.0 Category 'D'	AASHTO Designed for 30 Yrs
Howard Ave (Windsor/ LaSalle/ Tecumseh)	North of Hwy 3		Rural- Minor Arterial	FDR	50	75	500	750	40	95	450	720	113	SP12.5FC2 Category 'B'	SP 25.0 Category 'B'	Municipal Standards
	South of Hwy 3			FDR					40	90	400	660	109			
Cousineau Rd (Windsor)	North of Hwy 3		Urban- Major Collector	FDR and NC	40	65	450	660	50	70	450	690	98	HL 3	HL 8 (HS)	Municipal Standards
Sandwich West Pkwy (Windsor/ LaSalle)	South of Hwy 3 to Sta. 10+175		Urban- Major Collector	FDR	40	65	450	660	40	45+50	400	670	111	HL 3	HL 8 (HS)	
	South of Hwy 3 from Sta. 10+175			R (105 mm)	40	65	-	-	40	45	-	-	-			
Huron Church Line (LaSalle)	SBL South of Hwy 3 to Sta. 10+215		Urban- Minor Arterial	NC	40	60	450	650	40	50+55	450	740	119	HL 3	HL 8 (HS)	Municipal Standards
	SBL South of Hwy 3 from Sta. 10+215			R (100 mm)	40	60	-	-	40	50	-	-	-			
	NBL South of Hwy 3 to Sta. 10+191			NC	40	60	450	650	40	50+55	450	740	119			
	NBL South of Hwy 3 from Sta. 10+191			R (100 mm)	40	60	-	-	40	50	-	-	-			
Cabana Rd – (Windsor/ LaSalle)	From Sta. 9+760 to East of Huron Church Rd		Urban- Minor Arterial	NC	40	60	450	650	40	40+50	400	660	107	HL 3	HL 8 (HS)	Municipal Standards
	To Sta. 9+760			R	40	60	-	-	40	40	-	-	-			

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PARKWAY INFRASTRUCTURE CONSTRUCTORS acciona DRAGADOS FLUOR

Municipal Roadway	From[6]	To[6]	Road Classification	Rehabilitation Strategy[3,4]	Municipal Standards HMA[1] Surface (mm)	Municipal Standards HMA[1] Binder (mm)	Municipal Standards Gran A (mm)	Municipal Standards GBE (mm)	AASHTO 20 year Design HMA[1] Surface (mm)	AASHTO 20 year Design HMA[1] Binder (mm)	AASHTO 20 year Design Gran A (mm)	AASHTO 20 year Design GBE (mm)	AASHTO 20 year Design SN	Recommended Mix Type Superpave/Marshall Surface (mm)	Recommended Mix Type Superpave/Marshall Binder (mm)	Recommended Pavement Design
Todd Ln (LaSalle)	West of Huron Church Rd		Urban- Minor Arterial	FDR and NC	40	60	450	650	40	45+50	400	670	111			
Pulford St (Windsor)	East of Huron Church Rd		Urban- Minor Collector	NC	40	65	450	660	40	50	250	430	64	HL3	HL8(HS)	Municipal Standards
Grand Marais Rd (Windsor)	East of Huron Church Rd		Urban- Minor Collector	FDR	40	65	450	660	40	50	300	480	77			
Lambton St (Windsor)	West of Huron Church Rd to Sta. 10+159		Urban- Minor Collector	NC	40	65	450	660	40	50	250	430	70			
Matchette Rd (Windsor)[5]	North of E.C. Row Expwy		Rural Minor Arterial	R (105 mm)	40	65	-	-	40	60	-	-	-			
Howard Ave Connector (Tecumseh)	West of Howard Ave Diversion		Rural- Minor Arterial	NC	50	75	500	750	40	50+60	450	750	123	SP12.5FC2 Category 'B'	SP 19.0 Category 'B'	Municipal Standards
South Talbot Rd (Tecumseh)	East of Howard Ave Diversion		Rural- Major Collector	FDR	50	75	500	750	40	40+45	400	650	104	HL3 (HS)	HL8(HS)	Municipal Standards
North Talbot Rd (Tecumseh)	Sta .9+956 to Sta. 9+964 and Sta. 10+036 to Sta 10+044			FDR	50	75	500	750	40	50+50	400	680	115	SP12.5FC2 Category 'B'	SP 19.0 Category 'B'	AASHTO
	Sta. 9+920 to Sta. 9+956 and Sta. 10+036 to Sta. 10+070			R (125 mm)	50	75	-	-	40	50	-	-	-			
Laurier Pkwy (LaSalle)	To Sta. 6+683		Rural- Minor Arterial	R (100 mm)	40	60	-	-	40	85	-	-	-	SP12.5FC2 Category 'B'	SP25.0 Category 'B'	AASHTO
	From Sta. 6+683 to West of Howard Ave Diversion			FDR	40	60	450	650	40	85	500	750	103			
Howard Ave Diversion (Tecumseh)	South of Howard Connector		Rural- Minor Arterial	NC	50	75	500	750	40	50+65	450	760	126	SP12.5FC2 Category 'C'	SP19.0 Category 'C'	Municipal Standards
	North of Howard Connector to the Round About Sta. 10+000 to Sta. 10+500			NC	50	75	500	750	40	50+65	450	760	126			
Howard Ave (Tecumseh/LaSalle)	South of South Talbot Rd		Rural- Minor Arterial	FDR	50	75	500	750	40	95	500	770	131		SP25.0 Category 'C'	
All Other Municipal Roads[2]			Urban- Minor Collector	-	40	65	450	660	40	50	300	480	77	HL3	HL 4	Municipal Standards

Municipal Roadway	From[6]	To[6]	Road Classification	Rehabilitation Strategy[3,4]	Municipal Standards				AASHTO 20 year Design					Recommended Mix Type		Recommended Pavement Design
					HMA[1]		Gran A	GBE	HMA[1]		Gran A	GBE	SN	Superpave/Marshall		
					Surface	Binder			Surface	Binder				Surface	Binder	
					(mm)				(mm)					(mm)		
Cul-de-sac[2]			Urban- Local	FDR	40	50	300	480	40	60	350	550	87	HL3	HL 4	

Note:

1. For local Roads and Minor Collectors (Urban or Rural) the PGAC shall be 58-28 for both surface and binder course. For Major Collector and Minor Arterial (Urban or Rural) the PGAC shall be 64-28 for surface course and PGAC 58-28 for binder course.
2. Generic design.
3. Rehabilitation Strategies: (R) Resurfacing, (W) Widening, (RW) Resurfacing and Widening, (FDR) Full Depth Reconstruction and (NC) New Construction.
4. Where (R) resurfacing strategy has been indicated in the Table, the actual pavement condition has to be re-assessed prior to resurfacing.
5. Only for the pavement restoration at Culvert #53.
6. For exact extent of the pavement construction and/or rehabilitation refer to the New Construction drawings in the highway packages.

5.7 Flexible Pavement Design for Tunnel Decks

It is proposed that the tunnel decks form an integral part of the pavement design for the overlying roads listed in the table below. The minimum concrete slab deck thickness for the tunnels is approximately 225 mm. Overlying the concrete slab, will be the waterproofing membrane that consists of hot rubberized asphalt that shall meet OPSS 1213 Specification and placed and overlain by a protection board that shall comply with OPSS 1215. The purpose of the protection board is to prevent the paving equipment and the granular coarse aggregate from damaging the membrane. Protection boards are only used in parallel with the asphalt membrane.

A granular is proposed as a levelling layer to match the road base elevation on either side of the tunnel, followed by hot mix asphalt matching the roadway hot mix as indicated in the table below. Treated granular (OGDL) is recommended for ease of placement and compaction, particularly on sloped surfaces.

The design pavement GBE calculated for these roads using the Municipal Standards is in the range of 650 to 660 mm. Assuming a minimum OGDL layer of 100 mm, the minimum resulting GBE will be a minimum of 750 mm, which exceeds the Municipal Standard Design and meets the GBE for rural major collector and minor arterial for the Town of Tecumseh.

Pavement Section	Municipal Rd Standards				Pavement Design			
	HMA[1] (mm)		Gran A (mm)	GBE (mm)	HMA[1] (mm)	OGDL* (mm)	Concrete Slab (mm)	GBE (mm)
	Surface: SP 12.5 FC2 or HL 3	Binder: SP 19.0 mm or HL 4/HL 8						
GBE Factor	2.0		1.0		2.0	1.0	2.0	
(T3): Grand Marais Rd / Lambton St - Windsor	40	65	450	660	105	100 mm+ Variable	225 mm	760
(T6): Todd Ln/Cabana Rd - LaSalle	40	60	450	650	100			750
(T7): Huron Church Line - LaSalle	40	60	460	650	100			750
(T8): Geraedts Dr or St Clair College (Windsor)	40	65	450	660	105			760
(T9): Cousineau Dr – Windsor	40	65	450	660	105			760

Note1: Minimum HMA for 20 yrs as per the Municipal Standards. * OGDL thickness will vary to match with the final road grade.

5.8 Flexible Pavement Design for Overpasses and Underpasses

The Windsor-Essex Parkway will include 14 underpass and overpass structures to allow for grade-separation between Hwy 401, Hwy 3, ramps and crossing roads. It is proposed that the bridge decks form an integral part of the pavement design for the overpass and underpass roads listed below.

No traffic data information was available during the preparation of the pavement structure design for the bridge deck(s). The pavement topping was as per the MTO Structure Manual Clause 9.1.1 where the total thickness is 90 mm including 10 mm of the waterproofing membrane and 80 mm asphalt.

B-2 Matchette Rd. Overpass
B-3 Realigned E.C. Row-EBL Expwy Underpass near Matchette Rd.
B-4 Malden Rd. Overpass
B-5 Realigned E.C. Row-EBL Malden Rd. Overpass
B-6 Realigned E.C. Row-EBL Underpass at Huron Church Rd.
B-7 Hwy 3 Service Rd. Underpass near Grand Marais Rd.
B-8 Hwy 3 WB Overpass near Montgomery
B-9 EB Ramp Underpass near Huron Church
B-10 Hwy 3 Underpass West of Geraedt's Dr.
B-11 Hwy 3 Underpass near Montgomery Dr.
B-12 Howard Ave. Underpass
B-13 Hwy 3 Underpass, East of Howard Ave.
B-14 Hwy 401 (E-E/W) Underpass
B-15 North Talbot Rd. Underpass

Bridge ID-#	Type of Mix **Superpave or Marshall** SP 12.5FC2 Traffic Category 'E'	Concrete Slab	PGAC
B-2 to B-15	40+40 mm	225 mm	PGAC 70-28 for Surface Course

Prior of paving, the concrete deck surface shall meet the surface tolerance and surface finish as per the contract requirements. Also, it shall be free from dust or debris from the construction operation. Tack coat shall be applied uniformly at the required rate when the concrete is surface dry and clean. The tack coat shall be cured completely and free of any surface moisture and dirt before asphalt waterproofing membrane is applied. The membrane thickness will be measured as in the procedure of "Field Guide for the Acceptance of Hot Mix and Bridge Deck Waterproofing". Protection boards shall be tacked coated prior to paving.

5.9 Flexible Pavement Design for Trails

The trails were designed as per Ontario Bikeways Planning & Design Guidelines (MTO) as per the RFP in Article 9 'Urban design, landscape and ecological restoration design Criteria works'. Therefore, 50 mm of hot mix asphalt is enough to accommodate only bike traffic and light traffic. The hot mix shall be HL 3 (fine) or an equivalent Superpave mix such as SP 9.5 mm.

Trail Pavement Design

From	City	Class	HMA (mm)	Gran A (mm)	Total Thickness (mm)	GBE (mm)
Trails – Light Traffic	N/A	Light Traffic	50	300	350	400

The following table illustrates the hot mix type, lift thickness, and PGAC type making up the recommended asphalt thickness, in accordance with OPSS 1150, for the Trails.

Type	HMA Thickness (mm)	PGAC
HL3 (Fine)	50 mm	58-28
Total	50 mm	

5.10 Flexible Pavement Design for Commuter Parking Lot

A Commuter Parking Lot will be located near the intersection of Howard Avenue Diversion and Howard Avenue Connector. The following design parameters were chosen to calculate the required structural design of the flexible pavement for 20 years for a base year 2015 using the AASHTO method:

- No Traffic data available;
- Assumed Design ESALs = 150,000 (20 year structural design); SN = 85;
- Initial serviceability, Pi = 4.5;
- Terminal serviceability, Pt = 2.6;
- Mean subgrade resilient modulus = 30 MPa,
- Reliability level, R = 90 percent;
- Overall standard of deviation, So = 0.49;
- HMA layer coefficient, ai = 0.42;
- Granular A layer coefficient, ai = 0.14;
- Granular B Type II layer coefficient, ai = 0.14;
- Drainage coefficient for all layers, mi = 1.0

Recommended flexible pavement design for commuter parking lot (20 yrs design) for ESALs = 150,000

PAVEMENT CRITERIA				
Component	Design Criteria	Compaction Requirements	Depth	Accumulated Depth
Flexible Pavement	20 Years Design		90 mm	90 mm
Granular A	OPSS Form 1010	100% SPMDD	350 mm	440 mm

The following table illustrates the hot mix type, lift thickness, and PGAC type making up the recommended asphalt thickness, as well as the traffic category in accordance with OPSS 1151. It should be noted that the granular thickness for shoulder construction must be sufficient to match the base of the granular below the adjacent traffic lanes.

Type	HMA Thickness (mm)	PGAC	Traffic Category
SP 12.5 mm	40 mm	58-28	A
SP 19.0 mm	50 mm	58-28	A
Total	90 mm		

5.11 Flexible Pavement Design for Detours

Two options for flexible pavement design for detours were considered; the first was a design to support one (1) year of Hwy 401 cumulative traffic loadings, and the second design was to support two (2) years of Hwy 401 cumulative traffic loadings. The detours were designed as minor arterial. Hwy 401 ESALs for 1 year ESALs of 5,681,150and for 2 years ESALs of 11,416,839

- Design ESAL's = 6,000,000 (1 year structural design); SN = 136;
- Design ESAL's = 12,000,000 (2 years structural design); SN = 149;
- Initial serviceability, Pi = 4.5;
- Terminal serviceability, Pt = 2.5;
- Mean subgrade resilient modulus = 30 MPa,
- Reliability level, R = 90 percent;
- Overall standard of deviation, So = 0.49;
- HMA layer coefficient, ai = 0.42;
- Granular A layer coefficient, ai = 0.14;
- Granular B Type II layer coefficient, ai = 0.14; and
- Drainage coefficient for all layers, mi = 1.0.

Detour Pavement Design

Detour Number Road To Be Detoured	Location	Station		HMA (mm)	Gran A (mm)	Total Thickness (mm)	GBE (mm)
		From	To				
(D-5): Hwy 3 (3 Lns)	Howard Ave to Cousineau Dr	13+700	12+800	**180** (1 yr) **210** (2 yrs)	**450** (1 yr) **450** (2 yrs)	**630** (1 yr) **660** (2 yrs)	**810** (1 yr) **870** (2 yrs)
(D-4): Hwy 3 (4 Lns)	Huron Church Line	10+150	10+200				
(D-3): Huron Church/Hwy 3 (4+ Lns)	Cabana Rd to Pulford St	14+650	14+300				
(D-2): Huron Church /Hwy 3 (4+ Lns)	Grand Marais Rd to Labelle St	13+550	13+100				
(D-1): South Service Rd (2 Lns)	Grand Marais Rd to Labelle St	13+550	13+250				
(DS-1): Howard Ave (2+Lns)	10+000	9+717	10+151				

Detour Number Road To Be Detoured	Location	Station		HMA (mm)	Gran A (mm)	Total Thickness (mm)	GBE (mm)
		From	To				
(DS-2): Cabana/Todd Ln (2+ Lns)	10+100	9+800	10+300				
(DS-3): Huron Church Line	Huron Church Line	10+350	10+500				
(DS-4): St Clair College & Cosineau Dr	St Clair (11+550) / Cosineau Dr (11+750 to 12+200)						

As detours are temporary routes during construction, Marshall mixes could be used instead of Superpave mixes. If Marshall Mixes are used they shall conform to the requirements of the OPSS 1150 for Material Specification for Hot Mix Asphalt.

The following table illustrates the hot mix type, lift thickness, and PGAC type making up the recommended asphalt thickness, as well as the traffic category in accordance with OPSS 1150 and 1151.

Detour for 1 Year					Detour for 2 Year				
Type of Mix		HMA Thickness (mm)	PGAC	Traffic Category Note1	Type of Mix		HMA Thickness (mm)	PGAC	Traffic Category Note1
Superpave	Marshall				Superpave	Marshall			
SP 12.5	HL 3	40 mm	70-28	B	SP 12.5	HL 3	40 mm	70-28	C
SP 19.0 mm	HL 8	60 mm	64-28	B	SP 19.0 mm	HL 8	50 mm	64-28	C
SP 19.0 mm	HL 8	80 mm	58-28	B	SP 19.0 mm	HL 8	60 mm	58-28	C
					SP 25.0 mm	HL 8	60 mm	58-28	C
Total		180 mm			Total		210 mm		

Pavement Rehabilitation Strategies

Timing of maintenance and rehabilitation actions can greatly influence their effectiveness and cost. In general, once a pavement requires treatment, the sooner maintenance or rehabilitation activity is undertaken, the more cost-effective it will be. It is imperative to consider the following when choosing an appropriate strategy to realize the end result:

- Analyzing pavement needs;
- Prioritizing rehabilitation events to satisfy project needs;
- Selecting cost-effective rehabilitation options and strategies;
- Determining the cost and timing of maintenance and rehabilitation;
- Programming maintenance and construction;
- Formulating fiscal policy and allocating funds; and
- Managing cash flow and funding requirements.

Concrete Pavement Restoration:

Concrete restoration falls into two general categories; corrective activities and preventive activities. Corrective activities repair a given distress and improve the serviceability of the pavement. Full-depth repair and partial-depth repair are corrective activities. Preventive activities slow or prevent the occurrence of distress in order to keep the product in a serviceable condition. Joint and crack sealing, retrofitting concrete shoulders, and retrofitting edge drains are preventive techniques. Diamond grinding, dowel-bar retrofit, slab stabilization, cross stitching and grooving can act as both corrective and preventive techniques.

Rigid Pavement Maintenance and Rehabilitation Options:

Rehabilitation options that were considered for the rigid pavement design are detailed below.

- Partial-depth repair (PDR) corrects surface distress and joint/crack deterioration in the upper third of the concrete slab. When the deterioration is greater than ⅓ the slab depth or contacts embedded steel, a full-depth repair is recommended. Partial-depth repairs involve removing the deteriorated concrete layer, cleaning the patch area, placing new concrete, and reforming the joint system.
- Joint and crack resealing minimizes the infiltration of surface water and incompressible material (e.g., soil or debris) into the joint system. Minimizing water infiltration reduces the loss of subgrade or sub-base fines, and may limit the dowel corrosion caused by de-icing chemicals. Minimizing incompressible material infiltration reduces the potential for spalling and blow-ups. It is especially critical to reseal the joint along the pavement/ shoulder edge. Most of the surface water that enters the pavement system does so at the lane/shoulder longitudinal joints.
- Surface Texturization (Diamond Grinding and Grooving) to improve the skid resistance and promote better surface drainage.

Flexible Pavement Maintenance and Rehabilitation Options:

Flexible pavement maintenance and rehabilitation options that were considered are detailed below.

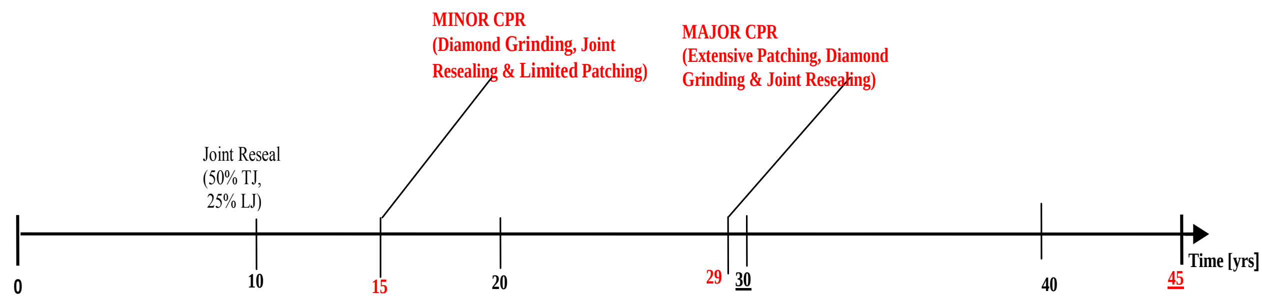
- Mill 40 mm/overlay 40 mm – This method involves cold milling the existing asphalt surface to a depth of 40+ mm. The milled areas are tack coated, conforming to OPSS 1103, Type SS1. The milled depth should be replaced with 1 lift of SP 12.5 mm FC2 hot mix. Advantages of this option (mill/overlay) include: a lower initial cost, traffic can travel on the milled surface (little traffic impact), and minimizing the grade increase of the roadway. The limitation is that it does not extend service life beyond 10 years without further intervention.
- Mill 50 mm/overlay 50 mm – This method involves cold milling the existing asphalt surface to a depth of 50+ mm. The milled areas are tack coated, with the tack coating conforming to OPSS 1103, Type SS1. The milled depth should be replaced with a 1 lift of SP12.5 mm FC2 hot mix. Advantages of this option (mill/overlay) include: a lower initial cost, traffic can travel on the milled surface (little traffic impact), and minimizing the grade increase of the roadway. The limitation is that it does not extend service life beyond 10 years without further intervention.
- Mill 40 mm/overlay 90 mm – This method involves cold milling the existing asphalt surface to a depth of 40+ mm. The milled areas are tack coated, with the tack coating conforming to OPSS 1103, Type SS1. The milled depth should be replaced with a 1 lift of SP 19.0 mm asphalt concrete binder course and a surface course layer of SP12.5 mm FC2 hot mix pavement. Advantages of this option (40 mm mill/90 mm overlay) include: a relatively low initial cost, traffic can travel on the milled surface (little traffic impact), and minimizing the grade increase of the roadway. The limitation is that it does not extend service life beyond 16 years without further intervention.
- Rout and seal – Cleaning and sealing cracks to minimize infiltration of moisture to ensure long-term pavement performance.

5.12 Windsor Essex Pkwy (Hwy 401 Extension) Rehabilitation Strategies

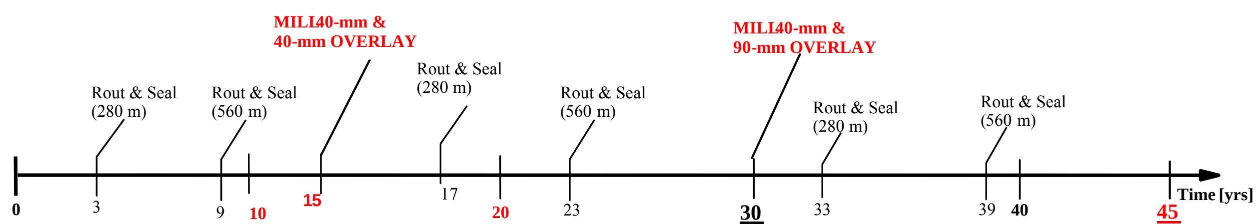
The MTO Guideline for LCCA on MTO Freeway Projects MERO-018 March 2005 was used to develop preventive strategies for flexible and doweled jointed plain concrete pavement rehabilitation. The model for pavement rehabilitation was modified based on experience, and adopted by the Design Team to sustain pavement life beyond 30 years for the required additional 15 years.

The following schematics illustrate preventive rehabilitation and maintenance required for design life of 45 years for rigid pavement and 30 years for flexible pavement. *The preventive strategies are for a 1-km long, 6-lane wide section for rigid or flexible pavements*.

Doweled Joint Plain Concrete Rigid Pavement (Designed for 45 Yrs)

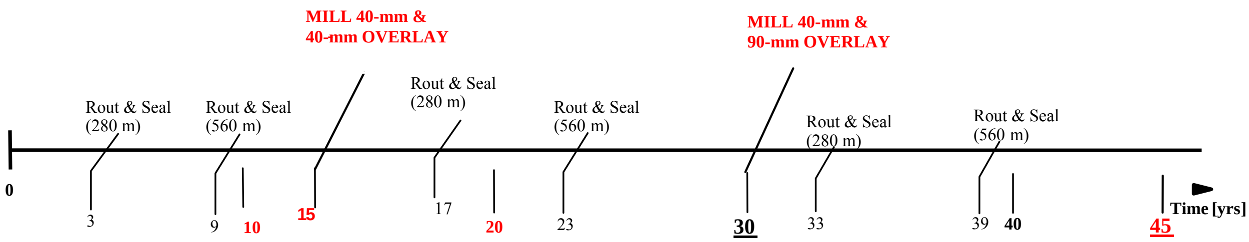


Hwy 401 Flexible Pavement, Superpave Mixes Designed for 30 Yrs)



Windsor Essex Pkwy (Hwy 401 Ramps) Rehabilitation Strategy The following schematic illustrates preventive rehabilitation and maintenance required for design life of 30 years for flexible pavement. *The preventive strategies are for a 1-km long, 6-lane wide section for flexible pavements.*

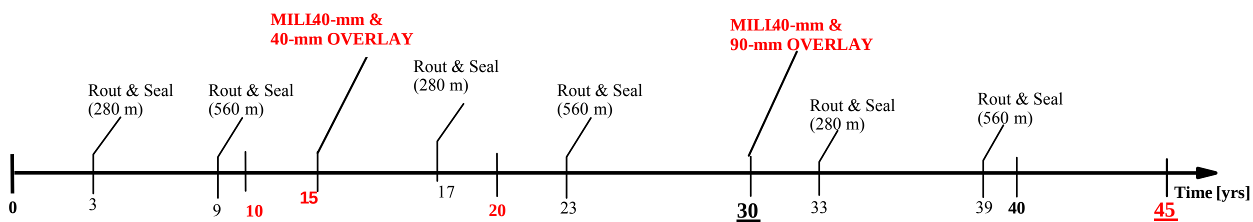
Hwy 401 Ramps: Flexible Pavement, Superpave (Designed for 30 Yrs)



5.13 Highway 3 Rehabilitation Strategies

The following schematic illustrates preventive rehabilitation and maintenance required for design life of 30 years for flexible pavement. The preventive strategies are for a 1-km long, 6-lane wide section for flexible pavements.

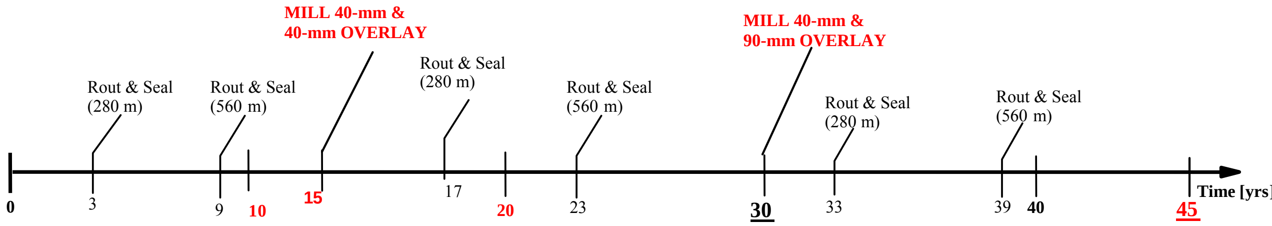
Hwy 3 Flexible Pavement, Superpave Mixes (Designed for 30 Yrs)



5.14 E.C. Row Expressway Eastbound Lane

The following schematics illustrate preventive rehabilitation and maintenance required for design life of 30 years for flexible pavement. The preventive strategies are for a 1-km long, 6-lane wide section for flexible pavements.

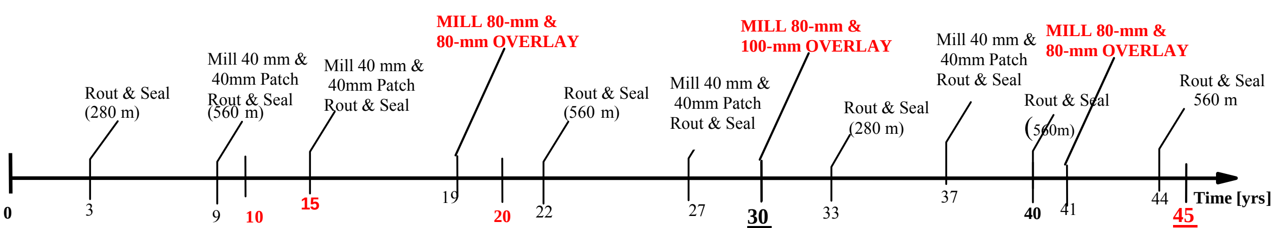
E.C. Row: Flexible Pavement, Superpave Mixes (Designed for 30 Yrs)



5.14.1 E.C. Row Expressway Ramps

The following schematics illustrate preventive rehabilitation and maintenance required for design life of 20 years for flexible pavement. The preventive strategies are for a 1-km long, 6-lane wide section for flexible pavements.

E.C. Row Ramps: Flexible Pavement, Superpave Mixes (Designed for 20 Yrs)



6 Recommendations and Construction Considerations

Paved shoulders for the entire project will comprise two lifts of hot mix. The lift thicknesses will be similar to the adjacent surface and upper binder courses. A full asphalt thickness and granular thickness should be extended in any areas where tracking onto a paved shoulder is considered likely, such as the inner loops of interchange ramps.

Preparation of the subgrade soils to meet the minimum design assumptions for all new pavements is crucial to the performance of the pavement structure. For further discussion on subgrade improvement methodology and recommendations to achieve the pavement design subgrade parameters refer to the "Preliminary subgrade improvement options are presented in the Subgrade Improvement Options Report included in 285380-04-119-0013. Options will be further defined following review of recommendations from geogrid manufacturers and an optimized design will be specified based on engineering parameters and cost effectiveness of the pavement structure".

The pavement structural designs are recommended for new construction provided that the subgrade is in suitable condition to proceed with construction. All subgrade conditions should be evaluated by the Geotechnical Engineer.

All granular base and sub-base material shall the corresponding OPSS Form 1010 requirements and be placed in lifts no greater than 200 mm thick, compacted to 100% of SPMDD. Granular base and sub-base thickness will be confirmed after detailed geotechnical investigation and confirmation of traffic data.

Asphalt performance grade should consist of PG 70-28 for the surface course and PG 64-28 for the top lift of the binder course for the Hwy 401 mainline, Ramps, E.C. Row Expressway and Hwy 3. The lower binder course lift(s) can be PG 64-28 and PG 58-28.

It is important that granular fill thicknesses beneath newly paved areas match the granular below adjacent areas, to avoid differential movements of the final surface. If the thicknesses do not match, frost tapers should be incorporated into the design as per OPSD.

The long-term performance of the pavement structure is highly dependent upon the subgrade support conditions. Stringent construction control procedures must be maintained to ensure that optimum subgrade moisture and density conditions are achieved. The subgrade surface should be properly crowned to ensure proper drainage of the Base and Sub-base materials. The subgrade and granulars should be drained by incorporating sub-drains and/or ditches.

The need for adequate drainage provisions cannot be overemphasized. The finished pavement surface should be free of depressions and should be sloped to provide effective drainage. It is preferred that drainage slopes be at least 2% and drainage paths be minimized.

The following Superpave hot mixes should be used on Hwy. 401, Hwy 401 Ramps, Hwy 3, E.C. Row Expressway, Detours, Tunnel Decks, and Commuter Parking Lots:

- SP 9.5 mm levelling mix should be used to correct cross fall and/or provide crown shifts;
- SP12.5 FC2 surface course mix should be used to provide the highway with high durability and a highly skid resistant riding surface; and
- SP 25.0 mm and SP19.0 mm should be used as binder course.

The following Marshall mixes shall be used for Municipal Roads, Trails and detours and shall be in accordance with OPSS 1150:

- HL 2 levelling mix should be used to correct cross fall and/or provide crown shifts;
- HL 3, HL 3 (high stability), and HL 3 (Fine) should be used as a surface course; and
- HL 4, HL 8, and HL 8 (high stability) should be used as a binder course.

Binders and Emulsions: As per Ministry Policy, all milled surfaces, existing surfaces and binder course surfaces will be tack coated prior to resurfacing. The PGAC for this location shall be PGAC 58-28 (Zone 3) for the binder course and PGAC 64-28 for the surface course. However, it is recommended that the high temperature grade be increased by one grade to 70-28, as the design ESALs is over 30 million. The Traffic is Category E.

Recycled Materials: Recycling of the existing pavement materials shall be permitted. The portions of reclaimed materials permitted in the various pavement materials shall be in accordance with OPSS 1010, OPSS 1151 and OPSS 1350.

The milled, reclaimed asphalt may be recycled and blended with granular materials to be used on the shoulders during the new construction for widening.

For ongoing evaluation, annual pavement condition surveys must be carried out using the Pavement Condition Index (PCI), International Roughness Index (IRI), rutting and friction measurements, to ensure the pavement condition meets the requirements of Schedule 15-3 of the project agreement.

Concrete Pavements shall be plain jointed concrete and incorporate a minimum 100 mm of OGDL beneath the slabs. Concrete joints and load transfer devices shall conform to the requirements of the OPSD 500 series. Concrete shall conform to the requirements of OPSS Concrete—Materials and Production.

Drainage of the Pavement structure shall be constructed in accordance with the OPSD 300 series and sub-drains shall be in accordance with OPSS 405.

Standards and Specifications

The following Ontario Provincial Standard Specifications for construction shall be followed:

Amendment of OPSS 350, MARCH 1998:

OPSS 314	Untreated Granular, Sub-base, Base, Surface, Shoulder and Stockpiling
OPSS 360	Full Depth Repair of Concrete Pavement or Concrete Base
OPSS 369	Sealing or Resealing of Joints and Cracks in Concrete Pavement
OPSS 904	Concrete Structures
OPSS 905	Steel Reinforcement for Concrete
OPSS 919	Formwork and Falsework

Ontario Provincial Standard Specifications, Material:

OPSS 1002	Aggregates - Concrete
OPSS 1302	Water
OPSS 1308	Joint Filler in Concrete
OPSS 1315	White Pigmented Curing Compounds for Concrete
OPSS 1350	Concrete - Materials and Production
OPSS 1441	Load Transfer Assemblies
OPSS 1442	Epoxy Coated Steel Reinforcement for Concrete

AASHTO (American Association of State Highway and Transportation Officials)

AASHTO M 182 –89 Standard Specification for Burlap Cloth made from Jute or Kenaf

Canadian Standards Association:

CSA A23.1/A23.2-0	Concrete Materials and Methods of Concrete Construction/ Methods of Test for Concrete
CSA A23.2-9C-04	Compressive Strength of Cylindrical Concrete Specimens
CSA A23.2-14C-04	Obtaining and Testing Drilled Cores for Compressive Strength Testing

Ministry of Transportation Publication:

MTO Laboratory Testing Manual:

LS-101 Procedures for Calculating Percent within Limits

LS-293 Method of Test for Correlating Profile Measuring Devices and Conducting Surface Smoothness Measurements

Asphaltic concrete shall conform to the requirements of the following:

OPSS 1150 Material Specification for Hot Mix Asphalt

OPSS 1151 Material Specification for Superpave and Stone Mastic Asphalt Mixtures

OPSS 206 Grading and compaction shall conform to the requirements

OPSS 501 Construction Specifications for Grading, and Construction Specification for Compacting. Granular base and sub-base shall be according to OPSS 314

OPSD 300 Series for Drainage of Pavement Structures

OPSS 405 Sub-drains

7 Risk and Limitation

Projected Traffic Data for the period 2015 to 2035 were obtained from Design Reference Document Golder Associates Report #05-1140-003-1, "Pavement Engineering for Planning Report Area of Continued Analysis Detroit River international Crossing Windsor, Ontario", March 2008.

The Growth Rate was not available in the Design Reference Document #05-1140-003-1 of Golder Associates "Pavement Engineering for Planning Report Area of Continued Analysis Detroit River international Crossing Windsor, Ontario" March 2008. A Growth Rate was back-calculated using the projected Traffic Data.

- A supplementary traffic data for Hwy 401 was received from Windsor Essex Mobility Group (WEMG), Excerpt from a Draft Report "Justification of ESALs for Pavement Engineering", June 2012 (Appendix A).

ESALs were calculated in accordance with Procedures for Estimating Traffic Loads for Pavement Design, 1995, MTO. This procedure resulted in lower values of ESALs than the Design Reference Document # 05-1140-003-1, Schedule 15-2.

Design Parameters were extracted from AASHTO pavement design parameters and selected as described in the MTO Materials Information Report MI-183 "Adaptation and Verification of AASHTO Pavement Design Parameters for Ontario Conditions".

Sub-surface and groundwater conditions were investigated by others (Design Reference Documents) for this Pavement Selection Report. The road design and geotechnical recommendations were based on the provided laboratory results at test locations spaced widely apart. Actual soil properties between and beyond the borehole locations may differ significantly, and conditions may become apparent during construction, which could not be detected or anticipated at the time of the preparation of the Pavement Selection Report.

The Modulus of Subgrade Reaction and Subgrade Resilient Modulus were extracted from the Design Reference Document #05-1140-003-1 "Pavement Engineering for Planning Report Area of Continued Analysis Detroit River International Crossing Windsor, Ontario" March 2008.

Subgrade conditions were extrapolated from the Design Reference Document #07-1130-207-0-R02/05-1140-003 "Sub-surface Condition Baseline Report", June 2009.

The flexible pavement design thicknesses and municipal roads are based on in-situ subgrade shall be modified/stabilized to achieve a minimum subgrade resilient modulus of **30 MPa**.

All rigid pavements are designed based on good subgrade condition with mean effective composite modulus of subgrade reaction of **81MPa/m.** This shall be achieved by subgrade improvement/stabilized.

Positive pavement subgrade drainage towards ditches, catch basins or manholes has been assumed as an integral part of the design. Care must be taken to ensure adequate drainage of the granular courses. In addition, due to the impervious nature of the underlying subgrade soil, sub-drains should be installed beneath the pavement structure to remove potential water accumulation.

Geotextile should be installed under the entire pavement structure for the mainline (Hwy 401), Hwy 3, Ramps and E.C. Row Expressway to ensure separation between the granulars and the subgrade (fine grained subgrade soils). This will not provide reinforcement or improvement to the subgrade. Subgrade improvements should be carried out as recommended in the geotechnical recommendations. This is crucial as pavement design is based on good performance of the Silty Clay/Clayey Silt subgrade.

For maintenance planning, the document Conventional Flexible Pavement Rehabilitation Strategy: MTO Guideline Use of LCCA on MTO Freeway Projects MERO-018 March 2005 was used. However, the Model for Conventional Flexible and Rigid Pavements were modified to sustain pavement life an additional 15 years.

The Municipal Standards of the City of Windsor, Town of LaSalle and Town of Tecumseh recommend using Marshall Mixes such as HL 3, HL 3 (HS) HL 4, HL 8, HL 8 (HS) and shall conform to the requirements of the OPSS 1150 for Material Specification for Hot Mix Asphalt. Several roads were selected for Superpave mixes for surface and binder courses, and shall conform to the requirements of the OPSS 1151 for Material Specification for Superpave and Stone Mastic Asphalt Mixtures.

The recommended pavement structural designs are based on parameters provided by others, AMEC's experience with similar projects, and general knowledge of the site conditions. Variations in subgrade soils/conditions may have a significant impact on the pavement designs. Site specific information and laboratory testing will be required to finalize pavement designs.
The information contained herein in no way reflects on the environmental aspects of the project, unless otherwise stated.

This document has been prepared for the titled project or named part thereof and should not be relied upon or used for any other project without an independent check being carried out as to its suitability and prior written authority of AMEC on behalf of HMM being obtained. AMEC on behalf of HMM accepts no responsibility or liability for the consequence of this document being used for a purpose other than the purposes for which it was commissioned. Any person using or relying on the document for such other purpose agrees, and will by such use or reliance be taken to confirm his agreement to indemnify AMEC on behalf of HMM for all loss or damage resulting therefrom. AMEC on behalf of HMM accepts no responsibility or liability for this document to any party other than the person by whom it was commissioned.

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8 Closure

The recommended pavement structural designs are based on parameters provided by others, AMEC's experience with similar projects, and general knowledge of the site conditions. Variations in subgrade soils/conditions may have a significant impact on the pavement designs.

All materials and construction methods must comply with current Ontario standards, and should be verified with properly implemented quality control and quality assurance testing programs.

The Risk and Limitations of Report, as provided in Section 8.0 form an integral part of this report.

Sincerely,
AMEC Environment & Infrastructure,
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Hoda Seddik, M.A.Sc., P.Eng.
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Jane Doucette, P.Eng.
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Yvette Hughes, M.A.Sc., P.Eng.
Associate Materials Engineer

10 References

1993 AASHTO Guide for the Design of Pavement Structures. For concrete pavements, both MTO's Routine Method as described in the SDO-90-01 Pavement Design and Rehabilitation Manual and the Canadian Portland Cement Association's Simplified Design Procedure shall be used in addition to the AASHTO design.

American Society for Testing and Materials (ASTM) Standards.

Athena Institute to Cement Association of Canada, "Life Cycle Perspective on Concrete and Asphalt Roadways: Embodied Primary Energy and Global Warming Potential", September 2006.

Becca Lane, MTO, A.W. (Sandy) Brown, Technical Director, Ontario Hot Mix Producers Association and Canadian Field Engineer, Asphalt Institute, Susan Tighe, Canada Research Chair and Associate Professor of Civil Engineering, University of Waterloo, "Perpetual Pavements: The Ontario Experiment, International Conference on Perpetual Pavements, Ohio", September 13-15, 2006".

Canadian Portland Cement Association – Thickness Design for Sts and Highways, and Asphalt Institute Thickness Design – Asphalt Pavement for Highways and St.

ERES Consulting to MTO SW Region, "Pavement Design Report W.P. 61-00-00, Hwy 401 Widening and Rehabilitation from 1.2 km West of Hwy 77 to 1.0 km East of Essex County Rd 42 Length 10.6 km, Townships of Tilbury West and Tilbury North Essex County Chatham District", March 2003.

Golder Associates Report #05-1130-209-2 to Dillon Consulting Limited, "Pavement Design Report – Hwy 401 Reconstruction from 0.4 km east of Hwy 3 Easterly 8.4 km to 1.5 km West of Manning Rd, GWP 64-00-00, Agreement No. 3004-E-0034, MTO – SW Region", March 2007.

Golder Associates Report #05-1140-003-1,"Pavement Engineering for Planning Report Area of Continued Analysis Detroit River international Crossing Windsor, Ontario, March 2008.

Golder Associates Report #07-1130-207-0-R02/05-1140-003, Geocres No. 40J6-28, "Windsor-Essex Pkwy Sub-surface Conditions Baseline Report", June 2009.

Ministry of Transportation Materials Information Report MI-183 "Adaptation and Verification of AASHTO Pavement Design Parameters for Ontario Conditions", AASHTO pavement design parameters shall be selected as described in the MTO Materials Information Report MI-183 "Adaptation and Verification of AASHTO Pavement Design Parameters for Ontario Conditions".

Ministry of Transportation, "Structural Manual", Provincial Highways Management Division Highway Standards Branch Bridge Office April, 2008.

Ministry of Transportation, “Ontario Bikeways Planning and Design Guidelines Shared Road Bikeways, Shoulder Bikeways, Bike Lanes and Bike Paths”, March 1996, Surveys & Design Office Downsview, Ontario

MTO Designated Sources of Material (DSM)

MTO Directive PHM-C-001 the Use of Surface Course Types on Provincial Highways

Procedures for Estimating Traffic Loads for Pavement Design, 1995, MTO

SDO-90-01, Pavement Design and Rehabilitation Manual (MTO)

SP-024 Manual for Condition Rating of Flexible Pavements and SP-026 Manual for Condition Rating of Rigid Pavements

The Formulations to Calculate Pavement Condition Indices, September 2009, Pavements and Foundations Section, MTO;

URS Report for W.O. 04-33-002, “The Windsor-Essex Pkwy Preliminary Design Report, Detroit River International Crossing Study, City of Windsor, County of Essex, Town of LaSalle, Town of Tecumseh”, November 2009.

Wilbur Smith in Association with IBI Group to Michigan DOT, “Preliminary Results of the Comprehensive Traffic and Toll Revenue Study for the Detroit River International Crossing Project Forecast Refresh and Update Traffic-Only Summary”, February 2010.

Windsor Essex Mobility Group (WEMG), Excerpt from a Draft Report “Justification of ESALs for Pavement Engineering”, June 2012 (Appendix A).

Appendix A Windsor Essex Mobility Group (WEMG), Excerpt from a Draft Report "Justification of ESALs for Pavement Engineering", June 2012.

Justification of ESALs for Pavement Engineering

Traffic Volumes

The Pavement engineering report by Golder Associates in 2008[1] indicated the traffic volumes of reference for years 2015, 2025 and 2035, a series for a total of 20 years.

This report showed a significant difference in heavy vehicle volumes between both directions; the maximum value was adopted in the Southbound/Eastbound direction.

The pavement has been designed from Canadian Plaza Ojibway Parkway to Highway 401 with a flexible pavement and a life cycle of 30 years, and from Highway 401 to Highway 3 with a rigid pavement of a life cycle of 45 years.

This implies the trend reflected in that report needs to be extended to cover these periods. In order to project these data, it has been taken into account the relative evolution of traffic in the Traffic and Toll Revenue Study for the Detroit River International Crossing (DRIC) by Wilbur Smith and Associates (WSA) in 2010[2].

Overall cumulative heavy traffic annual growth for the new crossing in this study by WSA in 2010 was 1.94% per annum between 2016 and 2060 (before ramp-up). This growth is the result of the evolution (nearly linear) from nearly 3,000 heavy vehicles in 2016 (2,747 before ramp-up) to 6,985 heavy vehicles in 2060.

On the other hand, the forecasted traffic in the Golder report in 2008 started from year 2007, before the world economic crisis. As already the update by Wilbur Smith pointed out, the crisis has meant a substantial decrease of traffic.

Border Crossing Heavy Traffic in 2011 is some 20.5% lower than in 2007[3]. Taking the necessary precautions, it could be expected that starting traffic in 2015 would be, with certain optimism, similar to that of 2007. This recovery would be reached with a cumulative yearly growth of 6% between 2011 and 2015, whilst the Traffic and Toll revenue study update in 2010 suggested 4.1% in the period 2009-2015, and the Golder report was proposing 3.8% growth for the period 2008-2015.

In the most optimistic scenario, assuming a sustained growth of 10.5% in the period (the steepest observed growth is 9.42% per annum in 1994-1999) starting traffic for year 2015 would be some 12% lower than expected in the Golder report. This has been the scenario for these calculations.

Load Equivalency Factor

Adopted Load Equivalency Factors (LEF) or Truck Factors follow recommendations in the *Procedures for Estimating Traffic Loads for Pavement Design* by the Ontario Ministry of Transportation (January , 1995).

According to the tables 3 and 6 in this report, a typical composition for a principal interurban arterial and corresponding truck factors per class provide an average value of 2.015 ESALs per heavy vehicle. (This is a relatively high factor in comparison with other values typically used, in the range of 1.8 to 1.9.)

Table 1. Traffic composition for a principal interurban arterial and corresponding Load Equivalency Factors (LEF) as per the *Procedures for Estimating Traffic Loads for Pavement Design (Tables 3 and 6 in the cited manual).*

Category	Typical composition in a principal interurban arterial	Typical Truck Factor per category
2 - 3 axles	25%	0.4
4 axles	5%	2.0
5 axles	45%	1.2
6+ axles	25%	5.1
Total	**100%**	**2.015**

[1] *Pavement engineering for planning report. Area of continued analysis Detroit River International Crossing. Windsor, Ontario.* Golder Associates, March 2008.

[2] *Preliminary Results of the Comprehensive Traffic and Toll Revenue Study for the Detroit River International Crossing Project Forecast Refresh and Update Traffic.* Wilbur Smith, February 2010.

[3] Border Crossing Statistics provided by the USDOT for the Michigan State in the RITA system 1994-2010, and a reported drop of 3% in the Ambassador bridge in 2011.

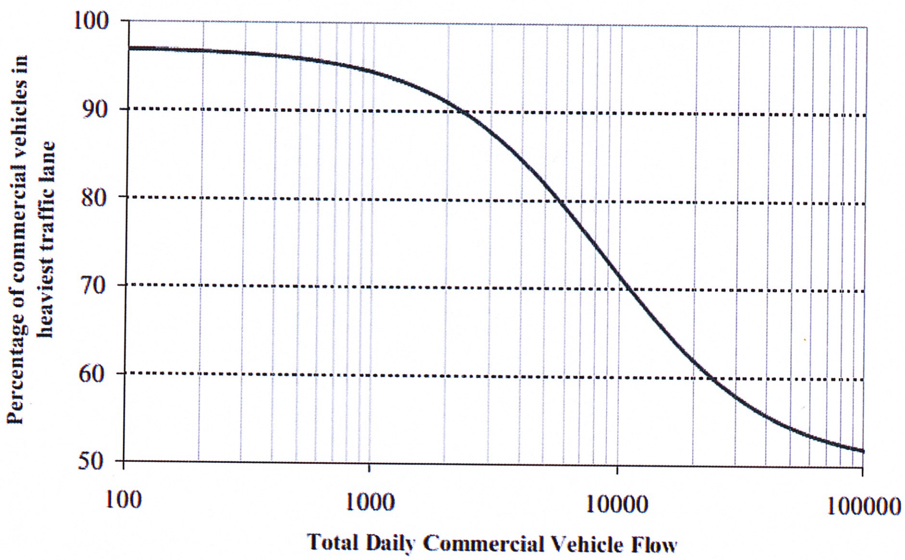
Lane Distribution Factor

Lane Distribution Factor (LDF) depends largely on the overall traffic. Table 5 in the above cited *Procedures for Estimating Traffic Loads for Pavement Design* suggests the following values for three lanes:

Table 2. Lane Distribution Factor in the *Procedures for Estimating Traffic Loads for Pavement Design (Table 5 in the cited manual).*

AADT Both directions	Lane Distribution Factor
<25,000	0.85
25,000 – 40,000	0.80
>40,000	0.70

Other manuals recommend this factor depending on the heavy traffic, providing similar results. In the case of the UK [add source] the following abacus is used:



In the light of these guidelines, for the purpose of these estimations, an overall average value of 0.75 was considered for the Lane Distribution Factor in the long term period of 45 years, and 0.77 in the 30 years period.

Data and calculations

Extracted from the Pavement Engineering report in 2008, the commercial Traffic in the Southbound/Eastbound direction (that of highest traffic), is reflected in Table 3 up to year 2035. These values of reference are taken for both directions.

Considering the impact of the crisis (a marginal reduction of 11% on starting traffic) and the trend identified in the DRIC Traffic update study (1.94% in the overall period 2015-2060) the traffic volume series complete, extrapolating from 2035 onwards, can be obtained as shown in Table 4.

A Lane Distribution Factor of 0.75 was considered for the Lane Distribution Factor in the 45 years period, and 0.77 in the 30 years period.

Finally, a uniform Load Equivalency Factor of 2.015 was applied, as explained above in Table 1.

In order to respect the data from the series, cumulated ESALs have been estimated with a linear trend between each of the years at the extremes of the periods.

Results of direct calculation of ESALs and final adopted values are reflected in Table 5.

In order to ease construction methods, ESAL values have been assigned in different groups, one for flexible pavement and three for rigid pavement, respecting maximum values obtained in each group.

Table 3. Commercial Traffic in the Southbound/Eastbound direction as per Pavement Report by Golder and Associates, 2008.

	SECTION	2015 AADT	2015 %COM	2015 COM	2025 AADT	2025 %COM	2025 COM	2035 AADT	2035 %COM	2035 COM
1	Canadian Plaza Ojibway Parkway/Highway 401 Southbound Off Ramp	17.980	52%	**9.350**	21.442	56%	**12.029**	24.132	58%	**14.093**
2	Ojibway Parkway/Highway 401 Southbound Off Ramp Ojibway Parkway/Highway 401 Southbound On Ramp	15.525	52%	**8.104**	18.806	56%	**10.607**	21.181	59%	**12.433**
3	Ojibway Parkway/Highway 401 Southbound On Ramp Highway 401 to E.C. Row Expressway Southbound Off Ramp	27.348	28%	**7.548**	34.180	33%	**11.109**	40.411	37%	**14.750**
4	Highway 401 to E.C. Row Expressway Southbound Off Ramp Huron Church Road/Highway 401 Southbound On Ramp	14.333	51%	**7.353**	18.677	55%	**10.347**	22.370	59%	**13.243**
5	Huron Church Road/Highway 401 Southbound On Ramp Pulford Street/Highway 401 Southbound Off Ramp	30.697	27%	**8.380**	36.588	31%	**11.342**	40.606	34%	**13.725**
6	Pulford Street/Highway 401 Southbound Off Ramp Todd Lane/Highway 401 Southbound Off Ramp	22.166	27%	**6.051**	26.254	31%	**8.139**	29.962	34%	**10.127**
7	Todd Lane/Highway 401 Southbound Off Ramp St. Clair College/Highway 401 Southbound Off Ramp	25.017	24%	**6.004**	29.442	28%	**8.244**	33.581	30%	**10.074**
8	St. Clair College/Highway 401 Southbound Off Ramp St. Clair College/Highway 401 Southbound On Ramp	19.250	30%	**5.775**	22.404	35%	**7.841**	24.397	40%	**9.759**
9	St. Clair College/Highway 401 Southbound On Ramp Howard Avenue Southbound On Ramp	22.874	35%	**7.983**	26.502	40%	**10.521**	29.449	44%	**12.810**
10	Howard Avenue Southbound On Ramp Highway 3/Highway 401 Southbound Off Ramp	27.843	36%	**10.107**	31.625	39%	**12.302**	33.686	39%	**13.239**
11	Highway 3/Highway 401 Southbound Off Ramp Highway 3/Highway 401 Southbound On Ramp	18.004	36%	**6.391**	21.212	40%	**8.570**	23.741	46%	**10.897**
12	Highway 3/Highway 401 Southbound On Ramp South of Highway 3 merge/split	21.530	36%	**7.815**	27.440	39%	**10.674**	32.317	42%	**13.605**

Table 4. Commercial Daily Traffic in the Southbound/Eastbound direction with recent update and long term forecast assumptions.

	SECTION	2015	2025	2035	2045	2055	2060
1	Canadian Plaza Ojibway Parkway/Highway 401 Southbound Off Ramp	8.234	10.594	12.412	14.700	16.949	18.025
2	Ojibway Parkway/Highway 401 Southbound Off Ramp Ojibway Parkway/Highway 401 Southbound On Ramp	7.137	9.341	10.950	12.969	14.953	15.902
3	Ojibway Parkway/Highway 401 Southbound On Ramp Highway 401 to E.C. Row Expressway Southbound Off Ramp	6.648	9.784	12.991	15.385	17.739	18.865
4	Highway 401 to E.C. Row Expressway Southbound Off Ramp Huron Church Road/Highway 401 Southbound On Ramp	6.476	9.113	11.663	13.813	15.926	16.938
5	Huron Church Road/Highway 401 Southbound On Ramp Pulford Street/Highway 401 Southbound Off Ramp	7.381	9.989	12.088	14.316	16.506	17.554
6	Pulford Street/Highway 401 Southbound Off Ramp Todd Lane/Highway 401 Southbound Off Ramp	5.330	7.168	8.919	10.563	12.179	12.952
7	Todd Lane/Highway 401 Southbound Off Ramp St. Clair College/Highway 401 Southbound Off Ramp	5.288	7.260	8.873	10.508	12.116	12.885
8	St. Clair College/Highway 401 Southbound Off Ramp St. Clair College/Highway 401 Southbound On Ramp	5.086	6.906	8.595	10.179	11.736	12.481
9	St. Clair College/Highway 401 Southbound On Ramp Howard Avenue Southbound On Ramp	7.031	9.266	11.282	13.362	15.406	16.384
10	Howard Avenue Southbound On Ramp Highway 3/Highway 401 Southbound Off Ramp	8.901	10.835	11.660	13.809	15.921	16.932
11	Highway 3/Highway 401 Southbound Off Ramp Highway 3/Highway 401 Southbound On Ramp	5.629	7.547	9.597	11.366	13.105	13.937
12	Highway 3/Highway 401 Southbound On Ramp South of Highway 3 merge/split	6.883	9.401	11.983	14.191	16.362	17.401

Table 5. Result of Cumulated ESALs

	SECTION	Pavement	Lifecycle (years)	2015 Commercial Vehicles	Cumulated growth in Lifecycle	Calculated ESALs	Adopted ESALs
1	Canadian Plaza Ojibway Parkway/Highway 401 Southbound Off Ramp	Flexible	30	8.353	2,0%	194.158.974	194.158.974
2	Ojibway Parkway/Highway 401 Southbound Off Ramp Ojibway Parkway/Highway 401 Southbound On Ramp	Flexible	30	7.240	2,0%	170.905.434	194.158.974
3	Ojibway Parkway/Highway 401 Southbound On Ramp Highway 401 to E.C. Row Expressway Southbound Off Ramp	Flexible	30	6.743	2,8%	190.313.188	194.158.974
4	Highway 401 to E.C. Row Expressway Southbound Off Ramp Huron Church Road/Highway 401 Southbound On Ramp	Flexible	30	6.569	2,6%	174.150.409	194.158.974
4	Highway 401 to E.C. Row Expressway Southbound Off Ramp Huron Church Road/Highway 401 Southbound On Ramp	Rigid	45	6.569	2,2%	297.905.026	314.016.012
5	Huron Church Road/Highway 401 Southbound On Ramp Pulford Street/Highway 401 Southbound Off Ramp	Rigid	45	7.487	1,9%	313.595.095	314.016.012
6	Pulford Street/Highway 401 Southbound Off Ramp Todd Lane/Highway 401 Southbound Off Ramp	Rigid	45	5.406	2,0%	229.952.235	229.952.235
7	Todd Lane/Highway 401 Southbound Off Ramp St. Clair College/Highway 401 Southbound Off Ramp	Rigid	45	5.364	2,0%	229.430.598	229.952.235
8	St. Clair College/Highway 401 Southbound Off Ramp St. Clair College/Highway 401 Southbound On Ramp	Rigid	45	5.159	2,0%	221.445.257	229.952.235
9	St. Clair College/Highway 401 Southbound On Ramp Howard Avenue Southbound On Ramp	Rigid	45	7.132	1,9%	292.774.159	314.016.012
10	Howard Avenue Southbound On Ramp Highway 3/Highway 401 Southbound Off Ramp	Rigid	45	9.029	1,4%	314.016.012	314.016.012
11	Highway 3/Highway 401 Southbound Off Ramp Highway 3/Highway 401 Southbound On Ramp	Rigid	45	5.710	2,0%	246.231.236	246.231.236
12	Highway 3/Highway 401 Southbound On Ramp South of Highway 3 merge/split	Rigid	45	6.982	2,1%	306.905.941	314.016.012