Part A: Contributions of this research

The motivations of this paper are:

MD

MVT

Partial charging

Time of charging to reduce the cast of charging

Methodology?

Time window

Substitution between buses

Energy consumption base on passenger load/deadhead trips

passenger satisfaction by defining time window

In comparison with (Yao et al., 2020)**:**

- partial charging is allowed.
- In addition, the cost of different time of use is considered. In the Yao et al. (2020) it is assumed the energy consumption rate is constant.
- Objective function: in the case of considering maximizing the number of trips (in the next steps).

Considering MVT:

EBs for multiple vehicle types can make scheduling more difficult, but their importance for the sustainable development of public transportation makes them worth studying (Yao et al., 2020). Also, operators can reduce scheduling costs by using multiple types of vehicles to meet fluctuating demand (Yao et al., 2020).

Considering substitution:

Hassold & Ceder (2014) applied substitution of buses in their model and could reduce the total schedule cost by more than 35%. After that Yao et al. (2020) implement the substitution for EBs and could reduce the cost by 16%.

Considering time window:

Based on (Wen et al., 2016) we consider $[a_j, b_j]$ interval to ensure that each timetabled trip would be started in the predefined interval.

We can also add in the next steps:

- the linear function used in this work could be replaced by a more realistic function to better describe the relation among charging time, charged amount and remaining battery level (it is recommended by Wen et al., 2016).
- Combining recharging station location and vehicle scheduling problem to determine the locations of the recharging stations at a strategic planning level (it is recommended by Wen et al., 2016).
- Considering unexpected events such as traffic accidents, extreme weather or route condition.

Part B: Assumptions

(Zhang et al., 2022):

A multi-depot transit network can be used to describe the problem as follow:

Given a set of depots,

A set of transit routes,

A set of electric vehicle types.

Each depot has a parking limit.

Each transit route has one or two or more terminals, and the deadhead distance and time from each depot to the terminal of each route are known.

Each route has a predefined timetable providing the start time and travel time of each trip.

Each electric vehicle type has a specific battery capacity, recharging rate, energy consumption rate and purchase price.

When the vehicle leaves the depot for the first time, its battery energy level is assumed to be full (constrain 10).

The vehicle can only operate on one or several predetermined routes and must strictly observe the time window of all trips.

Each trip must be covered exactly once.

The energy level of each vehicle in operation must be kept above the safe driving level, which is usually 20-30% of the battery capacity (constrain 5).

Partial charging: In each recharging activity, the vehicle can obtain any amount of energy at a fixed recharging rate up until it is fully charged (constraint 7).

After the vehicle has finished all its trips, it needs to return to the depot from which it departs (constraint 8).

(Van Kooten Niekerk et al., 2017):

During the day the batteries can be charged; in this paper we assume that a battery cannot be replaced/substituted

(Yao et al., 2020a):

If the vehicle needs to be recharged during operation, it needs to return to its departure depot for recharging after finishing the current trip or recharged at the nearest depot.

Unexpected events such as traffic accidents, extreme weather, etc., are not considered so that all trips can be performed as planned.

The energy consumption rate (i.e., the amount of energy consumed per unit distance) is fixed for a certain vehicle type under a certain load situation, but different EV types with different passenger loads have different energy consumption rates.

All chargers are homogeneous fast chargers, and each charger is equipped with one outlet.

To extend the battery life, the discharging depth of EBs for both types is set as 80%, i.e., $\alpha = 80\%$ (Paul & Yamada, 2014).

(Messaoudi & Oulamara, 2019) (Sassi et al., 2017)**:**

The optimization time horizon denoted by [0, T] is divided into T equidistant time periods t = 1,...,T, each period has a duration d and t represents the time interval [t − 1, t]. Our setting of d has been set at 15 minutes because EV manufacturers recommend at least 15 minutes for a charging phase to avoid undesirable chemical reactions in the lithium-ion batteries. (Constrain 11)

(Sassi et al., 2017)**:**

We assume the predetermined amount of electricity of grid that can be used for charging stations in our Model. (Constrain 12)

(L. Li et al 2019)**:**

In the MD-MVT-VSP, since each bus will complete a trip without switching to another one midway, the formulation only needs to deal with the starting and ending terminals.

Part C: Definitions of Parameters/ Variables:

(Yao et al., 2020):

Parameters	Description
V	the set of nodes, and V = O ∪ D ∪ Q
O	the origin of timetabled trips
D	the destination of timetabled trips
Q	the set of depots (q ∈ Q)
A	the set of trips including the timetabled trip for u ∈ U, the recharging trip, the in-depot or out-depot trip, and the deadheading trip.
G	G = (V, A)
P	the set of chargers (p ∈ P)
U	the set of vehicle types (u ∈ U)
S	the set of timetabled trips for all vehicle types (S= $\sum_{u \in U} S_u$)
S_u	the set of timetabled trips for type u (i, j ∈ S_u)
K	the set of EBs for all vehicle types (K= $\sum_{u \in U} K_u$)
K_u	the set of EBs for type u ($k_u \in K_u$)
P	the set of chargers (p ∈ P)
D_u	the maximum driving range of the EB for vehicle type u, in km
E_u	the maximum battery capacity of the EB for vehicle type u, in kwh
C_q^u	the capacity of depot q for vehicle type u
α	the discharging depth of EBs for all vehicle types
Θ_u	the recharging rate (i.e., the extended driving distance with the energy recharged per minute) of the EB for vehicle type u, in km/min
t_p^u	the recharging duration of the EB for vehicle type u, in min
e_i	end time of timetabled trip i, in min
s_j	start time of timetabled trip j, in min
$[a_j, b_j]$ (Wen et al., 2016)	Time interval of starting each trip j, in min
t_{ij}	the deadheading duration from the destination of i to the origin of j, in min
l_{iq}	deadheading distance between the destination of i and depot q, in km
l_{qj}	deadheading distance between depot q and the origin of j, in km
l_{ij}	deadheading distance between the destination of i and the origin of j, in km
l_i	driving distance of timetabled trip i, in km
l_i	driving distance of timetabled trip j, in km
α	the discharging depth of EBs for both types
g_t (Sassi et al., 2017)	electricity grid capacity available at t
c_t (Messaoudi & Oulamara, 2019) (Sassi et al., 2017)	The cost of electricity per kWh during period t, in $
[0, T] (Messaoudi & Oulamara, 2019)(Sassi et al., 2017)	optimization time horizon. This time horizon is divided into T equidistant time periods t.

t (Messaoudi & Oulamara, 2019)(Sassi et al., 2017)	t = 1, ..., T and it is discretization of T
d (Messaoudi & Oulamara, 2019) (Sassi et al., 2017)	the length of equidistant time periods t.
??? Not currently used: c_u	purchase cost of an EB for vehicle type u, in $
??? Not currently used: c_o	purchase and installation costs of a charger, in $
??? Not currently used: c_u^2	operating cost per unit deadheading distance of the EB for vehicle type u, in CNY /km
??? Not currently used: c_u^3	operating cost per unit passenger-carrying distance of the EB for vehicle type u, in CNY /km
??? Not currently used: δ	annualized factor
??? Not currently used: N	the number of operating days per year
Variables	description
Y_{k_u}	0-1 variable indicating if EB k_u has been used within a day
??? Not currently used: R_p	0-1 variable indicating if charger p has been used within a day
Z_i^p	0-1 variable indicating if the EB is recharged by charger p after performing timetabled trip i
$X_{k_u}^{ij}$	0-1 variable indicating if timetabled trips i and j are connected, and both performed by EB k_u
$X_{k_u}^{qj}$	0-1 variable indicating if EB k_u performs timetabled trip j after going out of depot q
$X_{k_u}^{iq}$	0-1 variable indicating if EB k_u goes into depot q after performing timetabled trip i
E_i	extended driving distance with the residual energy at the end of i, in km
E_j	extended driving distance with the residual energy at the end of j, in km
E_0 (Zhang et al., 2022)	extended driving distance with the residual energy at starting of day, in km
$S_{k_u}^q$	0-1 variable indicating if EB k_u departs from depot q at the beginning
$E_{k_u}^q$	0-1 variable indicating if EB k_u returns to depot q at the end of its schedule

Part D: Objective function (multi objective):

1) Minimizing the number of electric buses which are used in the fleet

$z_1 = \sum_{u \in U} \sum_{k_u \in K_u} Y_{k_u}$ (Messaoudi & Oulamara, 2019).

Or

$z_1 = \sum_{u \in U} \sum_{k_u \in K_u} \sum_{(q \in Q)} S^q_{k_u}$ (Janovec & Kohání, 2019)

2) Minimizing the electricity cost based on considering different prices in a day (Messaoudi & Oulamara, 2019) (Sassi et al., 2017).

$$z_2 = \sum_{u \in U} \sum_{k_u \in K_u} \sum_{\forall i,j \in S_u, Z_i^p = 1} (C_t * E_j) X^{ij}_{k_u} Z_i^p$$

or

$$z_2 = \sum_{i \in S_u} \sum_{u \in U} \sum_{k_u \in K_u} \sum_{t \in T} (\Theta_u \, t_p^u) * C_t * Z_i^p * Y_{k_u}$$

3) Not currently used ??? maximizing the total weights of tours processed by EBs (Sassi et al., 2017)

$$z_3 = Max \sum_{k_u \in K_u} \sum_{i,j \in S_u} l_i * l_j * X^{ij}_{k_u}$$

Part E: Constraints

1) Indicates that the EB cannot be recharged on more than one charger at the same time (Yao et al., 2020).

$$\sum_{\mathrm{p} \in \mathrm{P}} Z_i^p \leq 1$$

$\forall$ i $\in S_u$

2) specifies that each timetabled trip i can only be performed by one EB for a certain type. Besides, this constrain enforces that j is connected to one predecessor trip which can be either another timetabled trip i or an out- depot trip (Yao et al., 2020).

$$\sum_{\mathrm{u} \in \mathrm{U}} \sum_{k_u \in K_u} \left(\sum_{\mathrm{i} \in S_u} X_{k_u}^{ij} + \sum_{\mathrm{q} \in \mathrm{Q}} X_{k_u}^{qj} \right) = 1$$

$\forall$ j $\in S_u$, i $\neq$ j

3) specifies that each timetabled trip j can only be performed by one EB for a certain type. Besides, this constrain ensures that i is connected to one successor trip which can be either another timetabled trip j or an in-depot trip (Yao et al., 2020).

$$\sum_{\mathrm{u} \in \mathrm{U}} \sum_{k_u \in K_u} \left(\sum_{\mathrm{j} \in S_u} X_{k_u}^{ij} + \sum_{\mathrm{q} \in \mathrm{Q}} X_{k_u}^{iq} \right) = 1$$

$\forall$ i $\in S_u$, i $\neq$ j

4) provides the condition to ensure that i and j are connected (Yao et al., 2020).

$$e_i + t_{ij} X_{k_u}^{ij} \leq s_j$$

$\forall$ i, j $\in S_u$, $\forall$ $k_u \in K_u$

5) ensures that the residual energy in an EB should never be less than the lower limit before charging. In fact, tracks the energy level of the vehicle to ensure that it is always between the safe energy level and the maximum battery capacity (Zhang et al., 2022) (Yao et al., 2020).

$$(1 - \alpha) D_u \leq E_i - l_{iq} \leq D_u$$

$\forall$ i $\in S_u$, $\forall$ u $\in$ U

6) refers to the residual energy at the end of each timetabled trip (Yao et al., 2020).

$$E_j = E_i - l_{iq} + \Theta_u t_p^u - l_{qj} - l_j, \text{if } Z_i^p = 1$$

or

$$E_j = E_i - l_{ij} - l_j, \text{if } Z_i^p = 0$$

$\forall$ i, j $\in S_u$, $\forall$ u $\in$ U, $X_{k_u}^{ij} = 1$

7) ensures that the energy level of the vehicle after recharging does not exceed the maximum battery capacity (Zhang et al., 2022).

$$0 \leq \Theta_u t_p^u \leq D_u - (E_i - l_{iq})$$

$\forall$ i $\in S_u$, $\forall$ u $\in$ U

8) to facilitate the recharging and maintenance of EBs for multiple vehicle types, this constrain enforces that each EB eventually returns to the depot from which it departs after performing its schedule (Yao et al., 2020).

$$S_{k_u}^q = E_{k_u}^q$$

$\forall$ $k_u \in K_u$, $\forall$ q $\in$ Q

9) indicates that the number of EBs for a certain type housed in a depot overnight cannot exceed the depot capacity for this type (Yao et al., 2020).

$$\sum_{k_u \in K_u} S_{k_u}^q = \sum_{k_u \in K_u} E_{k_u}^q \leq C_q^u$$

$\forall$ q $\in$ Q, $\forall$ u $\in$ U

10) ensures that vehicles are fully charged when leaving the depot for the first time (Zhang et al., 2022).

$$E_0 = D_u$$

$\forall$ u $\in$ U

11) Ensures that recharging duration for each EB is at least 15 min to avoid undesirable chemical reactions in the lithium-ion batteries (Messaoudi & Oulamara, 2019) (Sassi et al., 2017).

$t_p^u \geq \mathrm{d}$

12) ensure that, the total power used to charge the EBs does not exceed the electricity grid's maximum capacity (Sassi et al., 2017).

$$\sum_{\mathrm{i} \in S_u} \sum_{u \in U} \sum_{k_u \in K_u} \left(\Theta_u \, t_p^u\right) * Z_i^p * Y_{k_u} \leq g_t$$

13) to ensure that each timetabled trip would be started in the predefined interval and avoid the customer dissatisfaction (Wen et al., 2016).

$$a_j \leq S_j \leq b_j$$

$\forall \mathrm{j} \in S_u$

14) Not currently used ??? ensure that, the number of recharging vehicles at a station can't exceed the station capacity (Tang et al., 2019).

Part F: Input Data

(Yao et al., 2020):

Number of depots	**2**
Number of routes	**6**
Number of types of EBs	**2**
Number of trips	**245**
Timetabled trips	Part H: For these timetabled trips, the earliest start time is set at 0 min, and the time step is set at one minute.
Electricity price (c_t)(Ontario energy Board: https://www.oeb.ca/)	From table 2-part G ($/kWh)
The recharging power of the charger	240 kW
??? Not currently used: the purchase and installation costs per charger	100,000 CNY
??? Not currently used: The fixed cost of a recharging trip (c1) (J. Q. Li, 2014)	13.4 CNY
??? Not currently used: Operating days per year (N)	360
??? Not currently used: Annualized factor (δ) (Wang et al., 2017)	0.1874
Parameters of GA:	
The population size	1000
The number of iterations	1000
The crossover probability	0.7
The mutation probability	0.1
The rate of elite individual retention	0.2

	Type1	**Type2**
Number of trips	???	???
The battery capacity (kWh)	204	120
??? Not currently used: The purchase cost of EBs (CNY)	2,300,000	1,500,000
The average energy consumption rate of EBs for carrying passengers (kW h/km) (Gao & Zou, 2016)	1.2	1
The average energy consumption rate of EBs for deadheading (kW h/km) (Gao & Zou, 2016)	1.1	0.9
The capacity of Depot 1	60	50
The capacity of Depot 2	30	40
The discharging depth of EBs (α) (Paul & Yamada, 2014)	80%	80%
The maximum driving range of the EB for vehicle type u, in km (D_u)	(204/1.2) = 107	(120/1) = 120
The recharging duration of the EB for vehicle type u, in min (t_p^u)	((204/240) *60) = 51	((120/240) *60) = 30
The recharging rate (i.e., the extended driving distance with the energy recharged per minute) of the EB for vehicle type u, in km/min (Θ_u)	(170/51) = 3.3	(120/30) = 4
??? Not currently used: Operating cost per unit deadheading distance of the EB for vehicle type u, in CNY/km (c_u^2)	(1*0.7) = 0.7	(0.9*0.7) = 0.63
??? Not currently used: operating cost per unit passenger-carrying distance of the EB for vehicle type u, in CNY /km (c_u^3)	(1.2*0.7) = 0.84	(1.1*0.7) = 0.77

Part G: Energy consumption price:

Ontario energy Board: https://www.oeb.ca/

Table1: Average price from May 2006 to Feb 2022

time of use (TOU)	Ave TOU price ($/kwh) ($c_t$)
Off- peak	6.86
Mid- peak	10.08
On- peak	13

https://www.oeb.ca/consumer-information-and-protection/electricity-rates:

Table 2: price based on TOU

time of use (TOU)	summer	Winter	TOU prices
Off- peak	7 am – 7 pm	7 am – 7 pm	8.2
Mid- peak	7 am – 11 am 5 pm – 7 pm	11 am – 5 pm	11.3
On- peak	11 am – 5 pm	7 am – 11 am 5 pm – 7 pm	17.0

https://www.oeb.ca/consumer-information-and-protection/electricity-rates:

Table 3: Price based on Tiered

Tier Thresholds	Winter (November 1 - April 30)	Summer (May 1 - October 31)	Tiered Prices (¢/kWh)
Tier 1	Residential – first 1,000 kWh/month	Residential – first 600 kWh/month	9.8
	Non-residential – first 750 kWh/month	Non-residential – first 750 kWh/month	
Tier 2	Residential – for electricity used above 1,000 kWh/month	Residential – for electricity used above 600 kWh/month	11.5
	Non-residential – for electricity used above 750 kWh/month	Non-residential – for electricity used above 750 kWh/month	

Part H: Windsor Transit Terminal (timetabled trips for 1C (West-East), Dominion (North-South), and Dougal (North-south))

Schedules & Maps (citywindsor.ca)

1C- West (rout No. 1):

This a West-East route which has 96 stops. It well be started from “forest glade at mulberry” terminal and ended at “hotel Dieu grace health care” terminal. There are 8 terminals with given arrival times as follows. The duration time of each trip is calculated. Each trip will be lasted about 77 min by average.

Weekdays Schedule of 1C (WESTBOUND)									
Trip	Forest Glade	Tecumseh Mall	Tecumseh & Rivard	Howard & Tecumseh	Ouellette & Wyandotte	Windsor International Transit Terminal	University of Windsor	Hotel Dieu Grace health care	Duration
1	5:20	5:29	5:36	5:44	6:03	6:09	6:14	6:24	1:04
2	5:45	6:00	6:10	6:18	6:37	6:45	6:49	6:59	1:14
3	6:15	6:30	6:40	6:48	7:07	7:15	7:19	7:29	1:14
4	6:45	7:00	7:10	7:18	7:37	7:45	7:49	7:59	1:14
5	7:15	7:30	7:40	7:48	8:07	8:15	8:19	8:29	1:14
6	7:45	8:00	8:10	8:18	8:37	8:45	8:49	8:59	1:14
7	8:15	8:30	8:40	8:48	9:07	9:15	9:19	9:29	1:14
8	8:45	9:00	9:10	9:18	9:37	9:45	9:49	9:59	1:14
9	9:15	9:30	9:40	9:48	10:07	10:15	10:19	10:29	1:14
10	9:45	10:00	10:10	10:18	10:37	10:45	10:49	10:59	1:14
11	10:20	10:37	10:47	10:55	11:15	11:23	11:28	11:38	1:18
12	10:40	10:57	11:07	11:15	11:35	11:43	11:48	11:58	1:18
13	11:00	11:17	11:27	11:35	11:55	12:03	12:08	12:18	1:18
14	11:20	11:37	11:47	11:55	12:15	12:23	12:28	12:38	1:18
15	11:40	11:57	12:07	12:15	12:35	12:43	12:48	12:58	1:18
16	12:00	12:17	12:27	12:35	12:55	1:03	1:08	1:18	1:18
17	12:20	12:37	12:47	12:55	1:15	1:23	1:28	1:38	1:19
18	12:40	12:57	1:07	1:15	1:35	1:43	1:48	1:58	1:18
19	1:00	1:17	1:27	1:35	1:55	2:03	2:08	2:18	1:18
20	1:20	1:37	1:47	1:55	2:15	2:23	2:28	2:38	1:18
21	1:40	1:57	2:07	2:15	2:35	2:43	2:48	2:58	1:18
22	2:00	2:17	2:27	2:35	2:55	3:03	3:08	3:18	1:18
23	2:20	2:37	2:47	2:55	3:15	3:23	3:28	3:38	1:18

24	2:40	2:57	3:07	3:15	3:35	3:43	3:48	3:58	1:18
25	3:00	3:17	3:27	3:35	3:55	4:03	4:08	4:18	1:18
26	3:20	3:37	3:47	3:55	4:15	4:23	4:28	4:38	1:18
27	3:40	3:57	4:07	4:15	4:35	4:43	4:48	4:58	1:18
28	4:00	4:17	4:27	4:35	4:55	5:03	5:08	5:18	1:18
29	4:20	4:37	4:47	4:55	5:15	5:23	5:28	5:38	1:18
30	4:40	4:57	5:07	5:15	5:35	5:43	5:48	5:58	1:18
31	5:00	5:17	5:27	5:35	5:55	6:03	6:08	6:18	1:18
32	5:20	5:37	5:47	5:55	6:15	6:23	6:28	6:38	1:18
33	5:40	5:57	6:07	6:15	6:35	6:43	6:48	6:58	1:18
34	6:00	6:17	6:27	6:35	6:55	7:03	7:08	7:18	1:18
35	6:15	6:32	6:42	6:50	7:10	7:18	7:23	7:33	1:18
36	6:45	7:02	7:12	7:20	7:40	7:48	7:53	8:03	1:18
37	7:15	7:32	7:42	7:50	8:10	8:18	8:23	8:33	1:18
38	7:45	8:02	8:12	8:20	8:40	8:48	8:53	9:03	1:18
39	8:15	8:32	8:42	8:50	9:10	9:18	9:23	9:33	1:18
40	8:45	9:00	9:10	9:18	9:37	9:45	9:49	9:59	1:14
41	9:15	9:30	9:40	9:48	10:07	10:15	10:19	10:29	1:14
42	9:45	10:00	10:10	10:18	10:37	10:45	10:49	10:59	1:14
43	10:15	10:30	10:40	10:48	11:07	11:15	11:19	11:29	1:14
44	10:45	11:00	11:10	11:18	11:37	11:45	11:49	11:59	1:14
45	11:15	11:30	11:40	11:48	12:07	12:15	12:19	12:29	1:14
46	11:45	12:00	12:10	12:18	12:37	12:45	12:49	12:59	1:14
47	12:15	12:30	12:40	12:48	1:07	1:15	1:19	1:29	1:14
									1:16
									Average

According to table 1 in Yau et al., 2020, the start time for the first trip is considered 0 and the starting and ending time (min) for each trip are calculated:

i		s_i (min)	Duration (min)	e_i (min)
1	0	0	64	64
2	25	25	74	99
3	30	55	74	129
4	30	85	74	159
5	30	115	74	189
6	30	145	74	219
7	30	175	74	249
8	30	205	74	279
9	30	235	74	309

i		s_i (min)	Duration (min)	e_i (min)
10	30	265	74	339
11	35	300	78	378
12	20	320	78	398
13	20	340	78	418
14	20	360	78	438
15	20	380	78	458
16	20	400	78	478
17	20	420	79	499
18	20	440	78	518
19	20	460	78	538
20	20	480	78	558
21	20	500	78	578
22	20	520	78	598
23	20	540	78	618
24	20	560	78	638
25	20	580	78	658
26	20	600	78	678
27	20	620	78	698
28	20	640	78	718
29	20	660	78	738
30	20	680	78	758
31	20	700	78	778
32	20	720	78	798
33	20	740	78	818
34	20	760	78	838
35	15	775	78	853
36	30	805	78	883
37	30	835	78	913
38	30	865	78	943
39	30	895	78	973
40	30	925	74	999
41	30	955	74	1029
42	30	985	74	1059
43	30	1015	74	1089
44	30	1045	74	1119
45	30	1075	74	1149
46	30	1105	74	1179
47	30	1135	74	1209
	24.1		**76.28**	

i		s_i (min)	Duration (min)	e_i (min)
	average		average	

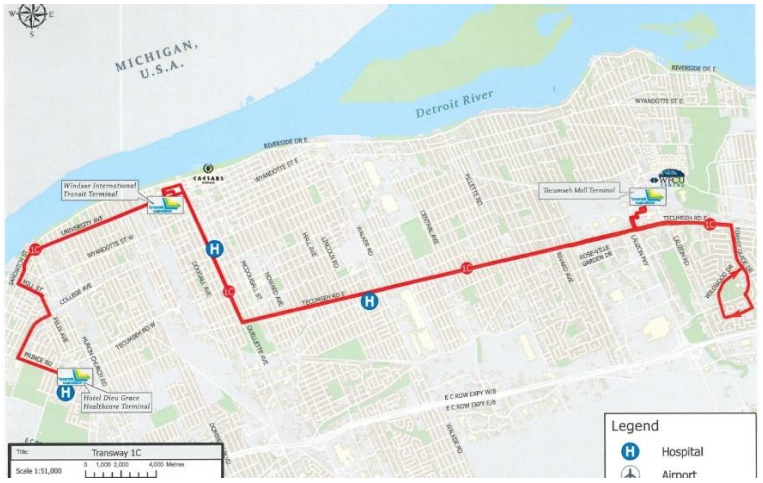
1C- East (rout No. 2):

Weekdays Schedule of 1C (East Bound)									
Trip	Hotel Dieu Grace health care	University of Windsor	Windsor International Transit Terminal	Ouellette & Wyandotte	Howard & Tecumseh	Tecumseh & Rivard	Tecumseh Mall	Forest Glade	Duration
1	5:34	5:42	5:49	5:53	6:14	6:23	6:37	6:44	1:10
2	6:04	6:12	6:19	6:23	6:44	6:53	7:07	7:14	1:10
3	6:34	6:42	6:49	6:53	7:14	7:23	7:37	7:44	1:10
4	7:04	7:12	7:19	7:23	7:44	7:53	8:07	8:14	1:10
5	7:34	7:42	7:49	7:53	8:14	8:23	8:37	8:44	1:10
6	8:04	8:12	8:19	8:23	8:44	8:53	9:07	9:14	1:10
7	8:34	8:42	8:49	8:53	9:14	9:23	9:37	9:44	1:10
8	9:04	9:12	9:19	9:23	9:44	9:54	10:09	10:16	1:12
9	9:34	9:42	9:49	9:53	10:14	10:24	10:39	10:46	1:12
10	10:04	10:12	10:19	10:23	10:44	10:54	11:09	11:16	1:12
11	10:24	10:32	10:39	10:43	11:04	11:14	11:29	11:36	1:12
12	10:44	10:52	10:59	11:03	11:24	11:34	11:49	11:56	1:12
13	11:04	11:12	11:19	11:23	11:44	11:54	12:09	12:16	1:12
14	11:24	11:32	11:39	11:43	12:04	12:14	12:29	12:36	1:12
15	11:44	11:52	11:59	12:03	12:24	12:34	12:49	12:56	1:12
16	12:04	12:12	12:19	12:23	12:44	12:54	1:09	1:16	1:12
17	12:24	12:32	12:39	12:43	1:04	1:14	1:29	1:36	1:12
18	12:44	12:52	12:59	1:03	1:24	1:34	1:49	1:56	1:12
19	1:04	1:12	1:19	1:23	1:44	1:54	2:09	2:16	1:12
20	1:24	1:32	1:39	1:43	2:04	2:14	2:29	2:36	1:12
21	1:44	1:52	1:59	2:03	2:24	2:34	2:49	2:56	1:12
22	2:04	2:12	2:19	2:23	2:44	2:54	3:09	3:16	1:12
23	2:24	2:32	2:39	2:43	3:04	3:14	3:29	3:36	1:12
24	2:44	2:52	2:59	3:03	3:24	3:34	3:49	3:56	1:12
25	3:04	3:12	3:19	3:23	3:44	3:54	4:09	4:16	1:12
26	3:24	3:32	3:39	3:43	4:04	4:14	4:29	4:36	1:12
27	3:44	3:52	3:59	4:03	4:24	4:34	4:49	4:56	1:12
28	4:04	4:12	4:19	4:23	4:44	4:54	5:09	5:16	1:12
29	4:24	4:32	4:39	4:43	5:04	5:14	5:29	5:36	1:12
30	4:44	4:52	4:59	5:03	5:24	5:34	5:49	5:56	1:12
31	5:04	5:12	5:19	5:23	5:44	5:53	6:07	6:14	1:10

32	5:24	5:32	5:39	5:43	6:04	6:14	6:29	6:36	1:12
33	5:44	5:52	5:59	6:03	6:24	6:34	6:49	6:56	1:12
34	6:04	6:12	6:19	6:23	6:44	6:53	7:07	7:14	1:10
35	6:34	6:42	6:49	6:53	7:14	7:23	7:37	7:44	1:10
36	7:04	7:12	7:19	7:23	7:44	7:53	8:07	8:14	1:10
37	7:34	7:42	7:49	7:53	8:14	8:23	8:37	8:44	1:10
38	8:04	8:12	8:19	8:23	8:44	8:53	9:07	9:14	1:10
39	8:34	8:42	8:49	8:53	9:14	9:23	9:37	9:44	1:10
40	9:04	9:12	9:19	9:23	9:44	9:53	10:07	10:14	1:10
41	9:34	9:42	9:49	9:53	10:14	10:23	10:37	10:44	1:10
42	10:04	10:12	10:19	10:23	10:44	10:53	11:07	11:14	1:10
43	10:34	10:42	10:49	10:53	11:14	11:23	11:37	11:44	1:10
44	11:04	11:12	11:19	11:23	11:44	11:53	12:07	12:14	1:10
45	11:34	11:42	11:49	11:53	12:14	12:23	12:37	12:44	1:10
46	12:04	12:12	12:19	12:23	12:44	12:53	1:07	1:14	1:10
47	12:34	12:42	12:49	12:53	1:14	1:23	1:37	1:44	1:10
									1:11

i		si (min)	Duration (min)	ei (min)
1	0	0	70	70
2	30	30	70	100
3	30	60	70	130
4	30	90	70	160
5	30	120	70	190
6	30	150	70	220
7	30	180	70	250
8	30	210	72	282
9	30	240	72	312
10	30	270	72	342
11	20	290	72	362
12	20	310	72	382
13	20	330	72	402
14	20	350	72	422
15	20	370	72	442
16	20	390	72	462
17	20	410	72	482
18	20	430	72	502
19	20	450	72	522
20	20	470	72	542

21	20	490	72	562
22	20	510	72	582
23	20	530	72	602
24	20	550	72	622
25	20	570	72	642
26	20	590	72	662
27	20	610	72	682
28	20	630	72	702
29	20	650	72	722
30	20	670	72	742
31	20	690	72	762
32	20	710	72	782
33	20	730	72	802
34	20	750	70	820
35	30	780	70	850
36	30	810	70	880
37	30	840	70	910
38	30	870	70	940
39	30	900	70	970
40	30	930	70	1000
41	30	960	70	1030
42	30	990	70	1060
43	30	1020	70	1090
44	30	1050	70	1120
45	30	1080	70	1150
46	30	1110	70	1180
47	30	1140	70	1210
	24.26		71.11	



Dominion 5_South (rout No. 3):

Dominion weekdays (SOUTHBOUND)						
Windsor International Transit Terminal	Campbell at Riverside	Campbell at Wyandotte	Campbell at Tecumseh	Dominion at Labelle	St. Clair College	Duration (min)
6:00	6:03	6:09	6:13	6:20	6:33	0:33
6:20	6:23	6:29	6:33	6:40	6:53	0:33
6:40	6:43	6:49	6:53	7:00	7:13	0:33
7:00	7:03	7:09	7:13	7:20	7:33	0:33
7:20	7:23	7:29	7:33	7:40	7:53	0:33
7:40	7:43	7:49	7:53	8:00	8:13	0:33
8:00	8:03	8:09	8:13	8:20	8:33	0:33
8:20	8:23	8:29	8:33	8:40	8:53	0:33
8:40	8:43	8:49	8:53	9:00	9:13	0:33
9:00	9:03	9:09	9:13	9:20	9:33	0:33
9:20	9:23	9:29	9:33	9:40	9:53	0:33
9:40	9:43	9:49	9:53	10:00	10:13	0:33
10:00	10:03	10:09	10:13	10:20	10:33	0:33
10:20	10:23	10:29	10:33	10:40	10:53	0:33
10:40	10:43	10:49	10:53	11:00	11:13	0:33
11:00	11:03	11:09	11:13	11:20	11:33	0:33
11:20	11:23	11:29	11:33	11:40	11:53	0:33
11:40	11:43	11:49	11:53	12:00	12:13	0:33
12:00	12:03	12:09	12:13	12:20	12:33	0:33
12:20	12:23	12:29	12:33	12:40	12:53	0:33
12:40	12:43	12:49	12:53	1:00	1:13	0:33
1:00	1:03	1:09	1:13	1:20	1:33	0:33
1:20	1:23	1:29	1:33	1:40	1:53	0:33
1:40	1:43	1:49	1:53	2:00	2:13	0:33
2:00	2:03	2:09	2:13	2:20	2:33	0:33
2:20	2:23	2:29	2:33	2:40	2:53	0:33
2:40	2:43	2:49	2:53	3:00	3:13	0:33
3:00	3:03	3:09	3:13	3:20	3:33	0:33
3:20	3:23	3:29	3:33	3:40	3:53	0:33

3:40	3:43	3:49	3:53	4:00	4:13	0:33
4:00	4:03	4:09	4:13	4:20	4:33	0:33
4:20	4:23	4:29	4:33	4:40	4:53	0:33
4:40	4:43	4:49	4:53	5:00	5:13	0:33
5:00	5:03	5:09	5:13	5:20	5:33	0:33
5:20	5:23	5:29	5:33	5:40	5:53	0:33
5:40	5:43	5:49	5:53	6:00	6:13	0:33
6:00	6:03	6:09	6:13	6:20	6:33	0:33
6:20	6:23	6:29	6:33	6:40	6:53	0:33
6:40	6:43	6:49	6:53	7:00	7:13	0:33
7:00	7:03	7:09	7:13	7:20	7:33	0:33
7:20	7:23	7:29	7:33	7:40	7:53	0:33
7:40	7:43	7:49	7:53	8:00	8:13	0:33
8:00	8:03	8:09	8:13	8:20	8:33	0:33
8:20	8:23	8:29	8:33	8:40	8:53	0:33
8:40	8:43	8:49	8:53	9:00	9:13	0:33
9:00	9:03	9:09	9:13	9:20	9:33	0:33
9:20	9:23	9:29	9:33	9:40	9:53	0:33
9:40	9:43	9:49	9:53	10:00	10:13	0:33
10:00	10:03	10:09	10:13	10:20	10:33	0:33
10:20	10:23	10:29	10:33	10:40	10:53	0:33
10:40	10:43	10:49	10:53	11:00	11:13	0:33
11:00	11:03	11:09	11:13	11:20	11:33	0:33
11:20	11:23	11:29	11:33	11:40	11:53	0:33

i		si	duration	ei
1	0	0	33	33
2	20	20	33	53
3	20	40	33	73
4	20	60	33	93
5	20	80	33	113
6	20	100	33	133
7	20	120	33	153
8	20	140	33	173
9	20	160	33	193
10	20	180	33	213
11	20	200	33	233
12	20	220	33	253
13	20	240	33	273
14	20	260	33	293
15	20	280	33	313
16	20	300	33	333
17	20	320	33	353
18	20	340	33	373
19	20	360	33	393
20	20	380	33	413

21	20	400	33	433
22	20	420	33	453
23	20	440	33	473
24	20	460	33	493
25	20	480	33	513
26	20	500	33	533
27	20	520	33	553
28	20	540	33	573
29	20	560	33	593
30	20	580	33	613
31	20	600	33	633
32	20	620	33	653
33	20	640	33	673
34	20	660	33	693
35	20	680	33	713
36	20	700	33	733
37	20	720	33	753
38	20	740	33	773
39	20	760	33	793
40	20	780	33	813
41	20	800	33	833
42	20	820	33	853
43	20	840	33	873
44	20	860	33	893
45	20	880	33	913
46	20	900	33	933
47	20	920	33	953
48	20	940	33	973
49	20	960	33	993
50	20	980	33	1013
51	20	1000	33	1033
52	20	1020	33	1053
53	20	1040	33	1073
			33	

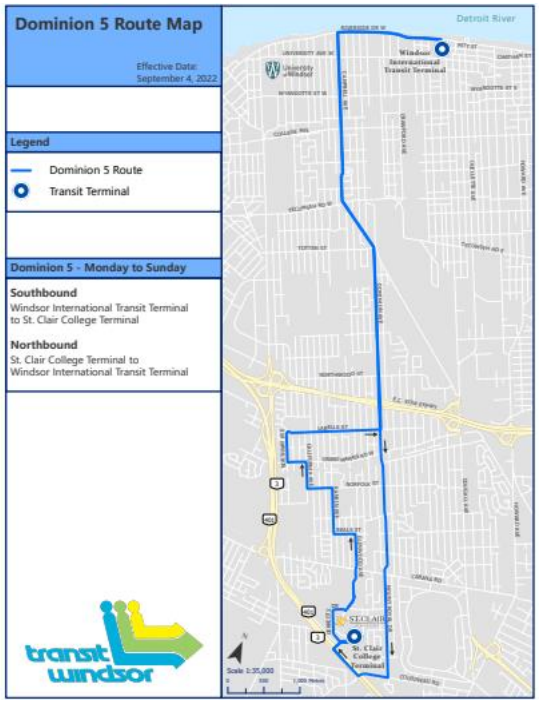
Dominion 5_North (rout No. 4):

Dominion weekdays (NORTHBOUND)						
St. Clair College	Labelle at Dominion	Campbell at Tecumseh	Campbell at Wyandotte	Campbell at Riverside	Windsor International Transit Terminal	Duration
6:39	6:53	7:00	7:06	7:12	7:15	0:36
6:59	7:13	7:20	7:26	7:32	7:35	0:36
7:19	7:33	7:40	7:46	7:52	7:55	0:36
7:39	7:53	8:00	8:06	8:12	8:15	0:36
7:59	8:13	8:20	8:26	8:32	8:35	0:36
8:19	8:33	8:40	8:46	8:52	8:55	0:36

8:39	8:53	9:00	9:06	9:12	9:15	0:36
8:59	9:13	9:20	9:26	9:32	9:35	0:36
9:19	9:33	9:40	9:46	9:52	9:55	0:36
9:39	9:53	10:00	10:06	10:12	10:15	0:36
9:59	10:13	10:20	10:26	10:32	10:35	0:36
10:19	10:33	10:40	10:46	10:52	10:55	0:36
10:39	10:53	11:00	11:06	11:12	11:15	0:36
10:59	11:13	11:20	11:26	11:32	11:35	0:36
11:19	11:33	11:40	11:46	11:52	11:55	0:36
11:39	11:53	12:00	12:06	12:12	12:15	0:36
11:59	12:13	12:20	12:26	12:32	12:35	0:36
12:19	12:33	12:40	12:46	12:52	12:55	0:36
12:39	12:53	1:00	1:06	1:12	1:15	0:36
12:59	1:13	1:20	1:26	1:32	1:35	0:36
1:19	1:33	1:40	1:46	1:52	1:55	0:36
1:39	1:53	2:00	2:06	2:12	2:15	0:36
1:59	2:13	2:20	2:26	2:32	2:35	0:36
2:19	2:33	2:40	2:46	2:52	2:55	0:36
2:39	2:53	3:00	3:06	3:12	3:15	0:36
2:59	3:13	3:20	3:26	3:32	3:35	0:36
3:19	3:33	3:40	3:46	3:52	3:55	0:36
3:39	3:53	4:00	4:06	4:12	4:15	0:36
3:59	4:13	4:20	4:26	4:32	4:35	0:36
4:19	4:33	4:40	4:46	4:50	4:53	0:34
4:39	4:53	5:00	5:06	5:12	5:15	0:36
4:59	5:13	5:20	5:26	5:32	5:35	0:36
5:19	5:33	5:40	5:46	5:52	5:55	0:36
5:39	5:53	6:00	6:06	6:12	6:15	0:36
5:59	6:13	6:20	6:26	6:32	6:35	0:36
6:19	6:33	6:40	6:46	6:52	6:55	0:36
6:39	6:53	7:00	7:06	7:12	7:15	0:36
6:59	7:13	7:20	7:26	7:32	7:35	0:36
7:19	7:33	7:40	7:46	7:52	7:55	0:36
7:39	7:53	8:00	8:06	8:12	8:15	0:36
7:59	8:13	8:20	8:26	8:32	8:35	0:36
8:19	8:33	8:40	8:46	8:52	8:55	0:36
8:39	8:53	9:00	9:06	9:12	9:15	0:36
8:59	9:13	9:20	9:26	9:32	9:35	0:36
9:19	9:33	9:40	9:46	9:52	9:55	0:36
9:39	9:53	10:00	10:06	10:12	10:15	0:36
9:59	10:13	10:20	10:26	10:32	10:35	0:36
10:19	10:33	10:40	10:46	10:52	10:55	0:36
10:39	10:53	11:00	11:06	11:12	11:15	0:36
10:59	11:13	11:20	11:26	11:32	11:35	0:36
11:19	11:33	11:40	11:46	11:52	11:55	0:36
11:39	11:53	12:00	12:06	12:12	12:15	0:36
11:53	12:08					#########

i		si	duration	ei
1	0	0	36	36
2	20	20	36	56
3	20	40	36	76
4	20	60	36	96
5	20	80	36	116
6	20	100	36	136
7	20	120	36	156
8	20	140	36	176
9	20	160	36	196
10	20	180	36	216
11	20	200	36	236
12	20	220	36	256
13	20	240	36	276
14	20	260	36	296
15	20	280	36	316
16	20	300	36	336
17	20	320	36	356
18	20	340	36	376
19	20	360	36	396
20	20	380	36	416
21	20	400	36	436
22	20	420	36	456
23	20	440	36	476
24	20	460	36	496
25	20	480	36	516
26	20	500	36	536
27	20	520	36	556
28	20	540	36	576
29	20	560	36	596
30	20	580	36	616
31	20	600	36	636
32	20	620	36	656
33	20	640	36	676
34	20	660	36	696
35	20	680	36	716
36	20	700	36	736
37	20	720	36	756
38	20	740	36	776
39	20	760	36	796
40	20	780	36	816
41	20	800	36	836
42	20	820	36	856
43	20	840	36	876
44	20	860	36	896
45	20	880	36	916
46	20	900	36	936
47	20	920	36	956

48	20	940	36	976
49	20	960	36	996
50	20	980	36	1016
51	20	1000	36	1036
52	20	1020	36	1056
53	14	1034	36	1070



Dougal 6_ south (rout No. 5):

DOUGALL 6 WEEKDAYS (SOUTHBOUND)					
Windsor Internationl Transit Terminal	Dougall at Tecumseh	Dougall at Norfolk	Country Club at Howard	St. Clair College	duration
5:55	6:03	6:12	6:21	6:28	0:33
6:30	6:38	6:47	6:56	7:03	0:33
7:10	7:18	7:27	7:36	7:43	0:33
7:50	7:58	8:07	8:16	8:23	0:33
8:30	8:38	8:47	8:56	9:03	0:33
9:10	9:18	9:27	9:36	9:43	0:33
9:50	9:58	10:07	10:16	10:23	0:33
10:30	10:38	10:47	10:56	11:03	0:33
11:10	11:18	11:27	11:36	11:43	0:33
11:50	11:58	12:07	12:16	12:23	0:33
12:30	12:38	12:47	12:56	1:03	0:33
1:10	1:18	1:27	1:36	1:43	0:33
1:50	1:58	2:07	2:16	2:23	0:33
2:30	2:38	2:47	2:56	3:03	0:33
3:10	3:18	3:27	3:36	3:43	0:33

3:50	3:58	4:07	4:16	4:23	0:33
4:30	4:38	4:47	4:56	5:03	0:33
5:10	5:21	5:32	5:43	5:55	0:45
5:48	5:56	6:05	6:14	6:21	0:33
6:58	7:06	7:15	7:24	7:31	0:33
8:08	8:16	8:25	8:34	8:41	0:33
9:25	9:33	9:42	9:51	9:58	0:33

i		si	durarion	ei
1	0	0	33	33
2	25	25	33	58
3	40	65	33	98
4	40	105	33	138
5	40	145	33	178
6	40	185	33	218
7	40	225	33	258
8	40	265	33	298
9	40	305	33	338
10	40	345	33	378
11	40	385	33	418
12	40	425	33	458
13	40	465	33	498
14	40	505	33	538
15	40	545	33	578
16	40	585	33	618
17	40	625	33	658
18	40	665	45	710
19	38	703	33	736
20	70	773	33	806
21	70	843	33	876
22	77	920	33	953

Dougal 6_ north (rout No. 5):

DOUGALL 6 WEEKDAYS (NORTHBOUND)					
St. Clair College	Country Club at Howard	Dougall at Norfolk	Dougall at Tecumseh	Windsor International Transit Terminal	duration
6:00	6:02	6:10	6:16	6:26	0:26
6:30	6:34	6:45	6:52	7:04	0:34
7:10	7:14	7:25	7:32	7:44	0:34
7:50	7:54	8:05	8:12	8:24	0:34
8:30	8:34	8:45	8:52	9:04	0:34
9:10	9:14	9:25	9:32	9:44	0:34
9:50	9:54	10:05	10:12	10:24	0:34
10:30	10:34	10:45	10:52	11:04	0:34

11:10	11:14	11:25	11:32	11:44	0:34
11:50	11:54	12:05	12:12	12:24	0:34
12:30	12:34	12:45	12:52	1:04	0:34
1:10	1:14	1:25	1:32	1:44	0:34
1:50	1:54	2:05	2:12	2:24	0:34
2:30	2:34	2:45	2:52	3:04	0:34
3:10	3:14	3:25	3:32	3:44	0:34
3:50	3:54	4:05	4:12	4:24	0:34
4:30	4:34	4:45	4:52	5:04	0:34
5:10	5:14	5:25	5:32	5:44	0:34
5:55	5:59	6:07	6:16	6:29	0:34
6:23	6:27	6:33	6:43	6:56	0:33
7:33	7:37	7:43	7:53	8:06	0:33
8:43	8:47	8:53	9:03	9:16	0:33
10:10	10:14	10:20	10:30	10:43	0:33

i		si	duration	ei
1	0	0	26	26
2	30	30	34	64
3	40	70	34	104
4	40	110	34	144
5	40	150	34	184
6	40	190	34	224
7	40	230	34	264
8	40	270	34	304
9	40	310	34	344
10	40	350	34	384
11	40	390	34	424
12	40	430	34	464
13	40	470	34	504
14	40	510	34	544
15	40	550	34	584
16	40	590	34	624
17	40	630	34	664
18	40	670	34	704
19	45	715	34	749
20	28	743	33	776
21	70	813	33	846
22	70	883	33	916
23	87	970	33	1003
	42.17		33.48	

Dougall 6 Route Map

Effective Date:
September 4, 2022

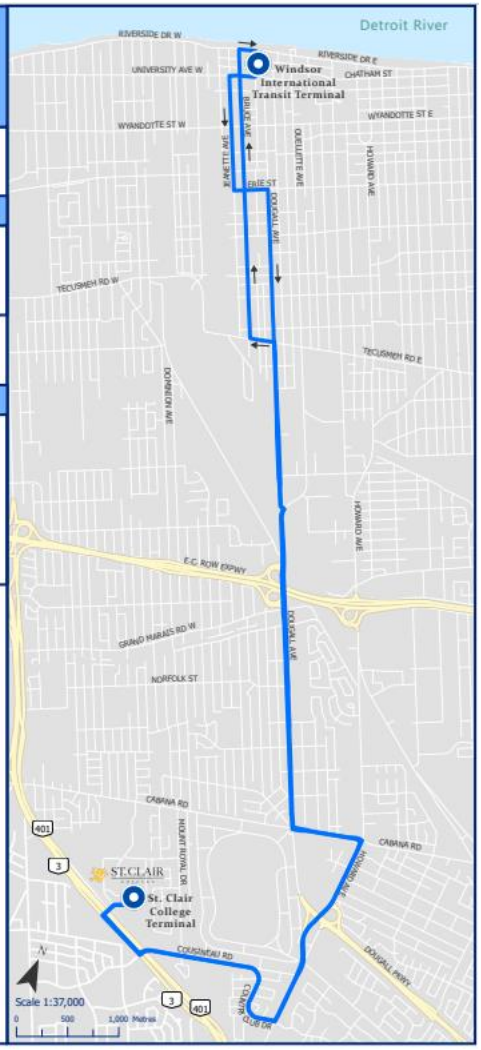
Legend

- Dougall 6 Route
- Transit Terminal

Dougall 6 - Monday to Sunday

Southbound
Windsor International Transit Terminal
to St. Clair College Terminal

Northbound
St. Clair College Terminal to
Windsor International Transit Terminal



transit windsor