



STAFF REPORT ACTION REQUIRED

Downtown Streetcar Routes – Travel Time Study of Extended Peak Period Regulations

Date:	April 18, 2016
To:	Toronto and East York Community Council
From:	General Manager, Transportation Services
Wards:	Wards 14, 18, 19, 20, 27, 28, 30, 32
Reference Number:	Ts2016105te.top.docx

SUMMARY

The Queen, Dundas and Carlton streetcar routes (referred in this report as "Downtown Streetcar Routes") carry approximately 115,000 passengers on an average weekday. In order to reduce congestion on these routes and improve the reliability of streetcars, peak hour restrictions on stopping, parking and turning were extended on sections of these routes in November and December 2015.

This report covers the results of the data collection and analysis of travel time changes to transit and traffic operations before and after peak hour restriction changes. Analysis of the TTC's Automatic Vehicle Location data reveal that in segments where no stopping hours are extended or new no left-turn signs are implemented, streetcar travel time has generally been reduced by approximately 1-1.5 minutes. For the entire Roncesvalles-to-Parliament corridor, the amended traffic regulations have saved as much as 3 minutes per streetcar trip. At certain route segments where peak hours were reduced, data indicate little to no change in streetcar travel time. The savings may contribute to better, more reliable transit service, and have the potential to add more flexibility in scheduling, reduced transit vehicle requirements, or increased service in the future. As a result of this study, peak hour restrictions have become more consistent across ward boundaries.

Also included in this report is a preliminary plan of operational changes currently being studied on other Toronto and East York District mixed-traffic streetcar route sections east of Parliament Street. A follow-up report recommending operational changes to improve streetcar service, i.e. extended peak hour restrictions, signal timing changes, etc., is expected to be submitted to Toronto East York Community Council in September 2016.

RECOMMENDATIONS

The General Manager, Transportation Services recommends that:

1. City Council enact the traffic and parking by-law amendments as set out in Appendix E.
2. City Council authorize and direct the appropriate City officials to take the necessary action to give effect to Council's decision, including the introduction in Council of any and all bills that may be required.

Financial Impact

There is no financial impact resulting from the receipt of this report.

DECISION HISTORY

City Council, at its meeting on September 30, October 1 and 2, 2015, directed "...the General Manager, Transportation Service[s] and the Chief Executive Officer of the Toronto Transit Commission (TTC) to monitor the results of the planned peak hour extensions on Queen Street, Dundas Street, and College/Carlton Streets in select segments between Roncesvalles Avenue and Parliament Street, and should the new data indicate, after the implementation of these changes and adjustments to traffic and transit operations, that there is a further opportunity to improve segment travel times through a similar extension of "No Stopping" hours on other sections of the streetcar network, the General Manager, Transportation Services be requested to report by March 2016 with a plan to complete the detailed analysis on the remaining mixed-traffic streetcar routes throughout the Toronto and East York District." (TE10.115).

<http://app.toronto.ca/tmmis/viewAgendaItemHistory.do?item=2015.TE10.115>

COMMENTS

Travel Time Analysis of Downtown Streetcar Routes

The changes to stopping prohibition hours, and in select cases, left-turn prohibitions, were implemented in late 2015 to reduce congestion-related delays to streetcars and general traffic, particularly where they were observed just beyond traditional peak hours. To measure the impacts of these changes, two sets of travel time data were analyzed on each downtown streetcar route over a two-week period – one in early November 2015 and another in early December 2015 – to collect "before" and "after" data. For example, travel time data of westbound 505 Dundas streetcars between Spadina Avenue and Dovercourt Road were analyzed throughout the new extended 3:30 p.m. to 6:30 p.m. peak period, to determine whether there was a significant change from previous conditions between 3:30 and 4:00 p.m. and 6:00 and 6:30 p.m. Another example involved streetcars passing through the intersection of Dundas Street West and Beverley Street,

where a new peak-hour left-turn prohibition was introduced in both directions. For all three downtown streetcar routes, there were more than 5900 data points collected during the entire study period.

Using the TTC's Automatic Vehicle Location (AVL) data, travel time is measured as the time elapsed while a streetcar traverses a corridor between two pre-determined points (usually between signalized intersections). Each hour is divided into two 30-minute intervals, e.g. 7:00 a.m. to 7:30 a.m. and 7:30 a.m. to 8:00 a.m., with the starting time of each streetcar marking the interval to which it is assigned. Given a set of streetcar runs corresponding to each interval, average travel time can be calculated per segment.

When a streetcar runs in a mixed-traffic environment, variability in travel times is often expected. Several factors such as driver and vehicle characteristics, traffic conditions, and weather fluctuations influence duration of travel. Thus, in most cases, travel time outcomes are dissimilar even for similar trips. A simple statistical tool – coefficient of variation – is used to account for relative variability of a sample data to the sample mean. It also gives an indication of whether travel time outcomes are reliable and replicable in the field. For unique cases, a statistical significance analysis with a 95% confidence level is carried out if average travel time of one or more interval veers away from a logical trend.

501 Queen

The charts in Appendix A illustrate the "before" and "after" impact of introducing and changing peak hour regulations on Queen St. In this set of charts, travel time data is only collected during the morning peak period for eastbound streetcars because a left turn prohibition at the Queen Street West / Gladstone Avenue intersection and extension of "No Stopping" (from 7:00 a.m. to 9:00 a.m. to 7:00 a.m. to 10:00 a.m.) between Dovercourt Road and Bathurst Street were implemented in this direction. Similarly, the survey only covers the afternoon peak period for westbound streetcars because of the new "No Stopping" hours between Shaw Street and Ossington Avenue. More than 2000 travel time runs were collected in this corridor throughout the study.

The first chart reveals negligible improvement to travel time for eastbound streetcars after implementing a left-turn prohibition at Queen Street West / Gladstone Avenue intersection. Each interval in the morning peak achieved no more than 10 seconds reduction in travel time. A check on the coefficient of variation (COV) as shown in Table 1 reveals low relative variability values in the "before" (20%) and "after" (19%) data, ensuring that the dispersion of collected sample data is not far away from the mean. The 1% difference points to evidence that very little benefit is gained from implementing this change and therefore it is recommended that the left-turn prohibition be removed. In contrast, the extension of no-stopping hours from 9:00 a.m. to 10:00 a.m. between Dovercourt Road and Bathurst Street yielded an average travel time decrease of 1 minute along the 1.6-kilometre segment on Queen Street West. Not only are streetcar operations benefiting from this savings over time, but in addition, the no-stopping hours (7:00 a.m. to 10:00 a.m.) in the eastbound direction are now consistent across four ward boundaries

spanning from Dufferin Street to Jarvis Street. To put this in context, that amount accounts for more than a 12% reduction of TTC's scheduled run time on the same segment of the route (see Table 3). The new stopping prohibition in the westbound direction (third and fourth chart of Appendix A) offered little change in travel time during the afternoon peak. This is somewhat expected because the affected segments are relatively short (520 metres between Dufferin Street and Dovercourt Road, and 220 metres between Shaw Street and Ossington Avenue) to expect varying travel time runs. Unlike the change in Queen Street / Gladstone Avenue, however, the new regulations here achieve a secondary purpose of making the restrictions consistent on Queen Street West between Bathurst Street and Roncesvalles Avenue, covering three wards. Especially for the short stretch near Ossington Avenue, previously recommended changes in the area had not been implemented in their entirety. The by-law changes have now removed the inconsistencies throughout this section.

505 Dundas

The "No Stopping" restrictions are extended to 3:30 p.m. to 6:30 p.m. in the westbound direction between Spadina Avenue and Dovercourt Road, and between Lansdowne Avenue and Roncesvalles Avenue. As a result, signs for motorists are now consistent across wards 14, 18, 19 and 20. As shown in the first two charts of Appendix B, the change has resulted in a modest savings of up to 30 seconds on average. However, a further inspection of raw data between Lansdowne Avenue and Roncesvalles Ave shows that time savings are as high as 1.5 minutes from 6:30 p.m. to 7:00 p.m. More than 2000 travel time runs were collected in this corridor throughout the study.

The Toronto East York Community Council, at its meeting on September 8, 2015, requested Transportation Services to examine the impacts of the left turn prohibition at Beverley Street to the local community (TE10.115). A segment analysis of travel time data between Spadina Avenue and University Avenue shows that eastbound streetcars are able to clear this stretch approximately 40 seconds (on average) faster in the morning peak than before. In the 9:00 a.m. peak hour, streetcars are moving considerably faster, saving nearly 1.5 minutes per trip. This results in approximately a 15% reduction in scheduled run time as shown in Table 3. The results of the left-turn restriction at Beverley Street in the westbound direction revealed an unusual trend in which the first afternoon peak hour trended upwards when travel times are expected to go down like the rest of the afternoon peak intervals. To ensure the validity of these outcomes, a statistical significance analysis was applied in this set of data. At the 95% confidence level, results for the whole afternoon peak period are significant and that the changes specifically in the first peak hour are not statistically significant (see Table 2). The highest savings, at more than 70 seconds, happens from 5:30 p.m. to 6:30 p.m. As for those impacted by the left-turn prohibition, available data from turning movement counts shows that around 40-50 vehicles per hour are affected and would need to take a different route. Based on TTC's surface stop riding count (2014), there are over 600 passengers at this location in a typical weekday who must also be factored in when considering the benefit of left-turn prohibition. In addition, there have been no complaints or negative feedback received from the community in relation to the new left-turn prohibitions. Suggestions to improve

cyclists' access to Beverley Street are currently under review by City of Toronto Cycling Infrastructure & Programs staff, and one particular option that is strongly considered is to paint bike boxes to facilitate safe turning from Beverley Street.

By scaling back the no-stopping period by one hour, travel time increased slightly by an average of 20 seconds in the eastbound direction between College Street and Dovercourt. Although this outcome does not meet the objective of improving streetcar operations and reducing variability in travel times, there is still value in keeping a consistent traffic regulation that now spans a longer segment of the corridor, benefitting all road users. Additionally, it achieves the elimination of a potential bottleneck at Dovercourt Road, and it was found that travel times improved over the longer corridor.

506 Carlton

Major changes to stopping prohibitions are primarily focused on these two segments – on College Street between Dovercourt Road and Manning Avenue, and on Carlton Street between Elizabeth Street and Parliament Street. Morning and afternoon peak hour no-stopping regulations were also implemented in the westbound direction between Yonge Street and Bay Street. Of all the changes, the Carlton streetcar achieves the highest travel time savings in the eastbound direction at nearly 3 minutes per trip from 6:30 to 7:00 p.m. The 3:00 p.m. to 3:30 p.m. interval had different results, and thus a statistical significance test was carried out similar to the previous example in this section. The analysis showed that this interval is not statistically significant. Discounting this result, the re-calculated average travel time savings in this corridor would be approximately 100 seconds (up from 60 seconds in the chart). More than 1900 travel time runs were collected in this corridor throughout the study.

With the exception of the stopping prohibitions in the westbound direction between Manning Avenue and Dovercourt Road, the other charts achieve an average travel time savings between 10 and 30 seconds in their respective peak hour restrictions and correspond to a 4%-10% decrease in scheduled run times accordingly (see Table 3) The COV for each segment is low, indicating less variability in the sample size, as can be seen in the table below. For the westbound streetcar between Manning Avenue and Dovercourt Road, variability in travel times was reduced in all intervals even if average travel times themselves were not.

Summary of travel time variability test and impact to schedule run times

Table 1. Coefficient of Variation

Streetcar	From	To	Dir	Change	COV before (%)	COV after (%)	Diff* (%)	Std Error
Queen	Dufferin	Dovercourt	EB	No left turn	20.03	18.72	1.31	1.42
Queen	Dovercourt	Bathurst	EB	No stopping	17.21	12.22	4.99	0.26
Queen	Shaw	Ossington	WB	No stopping	36.29	31.91	4.38	2.31
Queen	Dovercourt	Dufferin	WB	No stopping	27.40	23.62	3.78	2.55
Dundas	Spadina	Dovercourt	WB	No stopping	14.28	9.65	4.63	0.20
Dundas	Lansdowne	Roncesvalles	WB	No stopping	18.46	18.81	0.35	0.72
Dundas	Spadina	University	EB	No left turn	26.35	17.87	8.48	2.14
Dundas	University	Spadina	WB	No left turn	24.65	24.20	0.45	3.44
Dundas	College	Dovercourt	EB	No stopping	14.20	14.44	0.24	1.59
Carlton	Dovercourt	Manning	EB	No stopping	16.03	12.63	3.40	0.09
Carlton	Manning	Dovercourt	WB	No stopping	17.96	13.52	4.44	0.63
Carlton	Elizabeth	Parliament	EB	No stopping	19.14	11.10	8.04	1.64
Carlton	Yonge	Bay (AM)	WB	No stopping	32.53	30.05	2.48	4.55
Carlton	Yonge	Bay (PM)	WB	No stopping	34.42	31.54	2.88	1.51

*absolute positive value

Table 2. Statistical Significance Test (95% confidence level)

Streetcar	From	To	Dir	Change	Travel time before	Travel time after	Std Error	Sample size	Stat significant
Dundas	University	Spadina	WB	No left turn 3:30pm	5.93	6.11	1.54	33	No
				No left turn 4:00pm	5.58	6.15	1.84	35	No
College	Elizabeth	Parliament	EB	No stopping 3:00pm	12.17	12.61	1.72	17	No

Table 3. Impact of Peak Hour Restriction Changes Relative to Scheduled Run Times

Streetcar	From	To	Dist (km)	Avg travel time savings (min)	Estimated TTC scheduled run time (min)*	% reduction
501 Queen	Dufferin	Dovercourt	0.52	0.06	2.13	2.8
	Dovercourt	Bathurst	1.54	0.96	7.60	12.6
	Shaw	Ossington	0.22	0.06	1.28	4.7
	Dovercourt	Dufferin	0.52	0.05	2.05	2.4
505 Dundas	Spadina	Dovercourt	2.24	0.34	11.04	3.1
	Lansdowne	Roncesvalles	1.07	0.23	4.00	5.8
	Spadina	University	0.80	0.64	4.20	15.2
	University	Spadina	0.80	0.29	5.38	5.4
506 Carlton	College	Dovercourt	1.31	-0.35	3.68	-9.5
	Dovercourt	Manning	1.15	0.51	4.81	10.6
	Manning	Dovercourt	1.15	0.02	5.52	0.3
	Elizabeth	Parliament	1.63	1.14	18.72	6.1
	Yonge	Bay	0.23	0.14	3.62	3.9
	Yonge	Bay	0.23	0.32	4.58	7.0

* Adjusted to coincide with route sections at which by-law amendments were implemented

Impacts on General Traffic

To supplement the findings on streetcar travel times, general traffic travel times were also collected and analyzed. Findings to date show that these travel times (collected with Bluetooth detectors) have been reduced by approximately 5 percent on Dundas Street and College Street between Bathurst Street and Dovercourt Road in the new morning and afternoon peak periods, and by a similar amount on Dundas Street West between 6:00 p.m. and 6:30 p.m. on the sections from Spadina Avenue to Dovercourt Road and Sterling Road to Roncesvalles Avenue. This change amounts to a positive impact for all traffic, up to approximately 30 seconds of travel time savings just in each segment, in addition to the savings for streetcar travel.

Conclusion

Given that the change to peak hour restrictions demonstrated significant travel improvements to 501 Queen, 505 Dundas and 506 Carlton operations as well as provided consistency in sign prohibitions, it is recommended to maintain all the enacted by-law traffic regulations except the left-turn prohibition at Queen Street West / Gladstone Avenue intersection as listed in Appendix E.

Preliminary Study of Toronto and East York District (East End Streetcar Network)

As requested by City Council, Transportation Services is currently undertaking a similar study for the streetcar routes east of Parliament Street to the eastern boundary of Toronto and East York District (see Appendix D). A number of intersections are being monitored to understand the prevailing traffic conditions, to identify segments where streetcars are operating at slow speeds and to review current transit signal priority and signal timing. Similar to the earlier study, the objective is to find opportunities to improve travel times and reliability of streetcar routes by recommending the following measures where appropriate:

- Introducing stopping and turning prohibitions;
- Extending the hours of existing parking, stopping and turning restrictions; and
- Implementing transit signal priority or otherwise modifying signal timing

Table 4 below lists intersections and street segments that are being considered for the above changes. Detailed recommendations developed in this study, which will consider relative benefits and impacts and will determine which measures will likely be effective given observed traffic patterns and causes of delay, are anticipated to be reported to Toronto and East York Community Council in September 2016.

Table 4. Candidate list of intersections under consideration

Corridor	Intersection/Segment	Direction
Queen Street East	Between Woodbine Avenue and Wineva Avenue	Eastbound
	Between Logan Avenue and Carlaw Avenue	Westbound
	Between Carroll Street and McGee Street	Eastbound
Coxwell Avenue	Between Gerrard Street East/Fairford Avenue and Gerrard Street East/Eastwood Road	Southbound
	Intersection with Gerrard Street East/ Eastwood Road	Northbound and Southbound
Gerrard Street East	Intersection with Parliament Street	Westbound
Parliament Street	Intersection with Carlton Street	Northbound and Southbound
Broadview Avenue	Between Gerrard Street East and Danforth Avenue	Northbound
Kingston Road	Between Glenmanor Drive and Victoria Park Avenue	Eastbound
	Intersection with Victoria Park Avenue	Southbound
	Between Main Street/ Southwood Road and Scarborough Drive	Westbound

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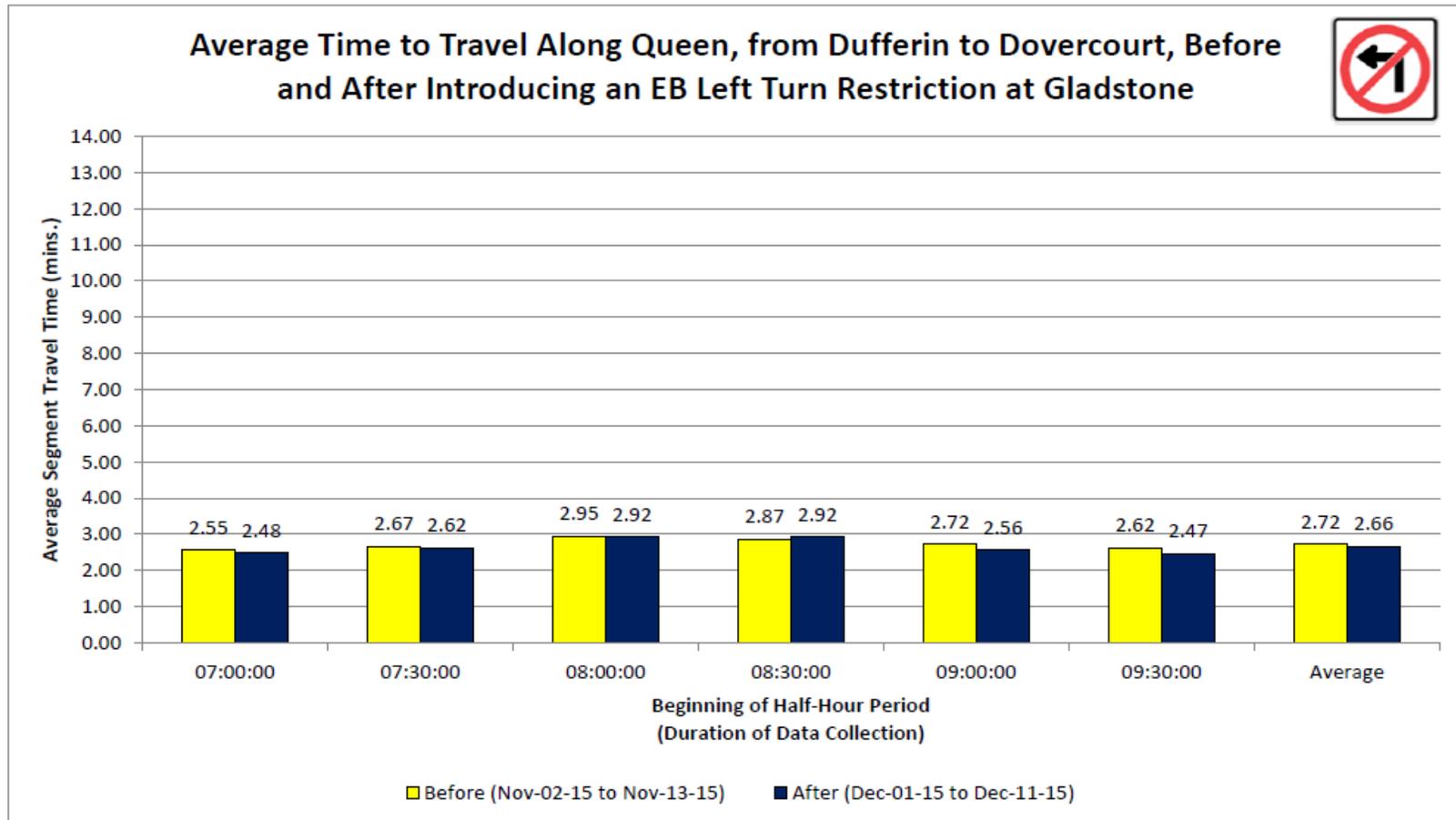
Stephen M. Buckley
General Manager, Transportation Services

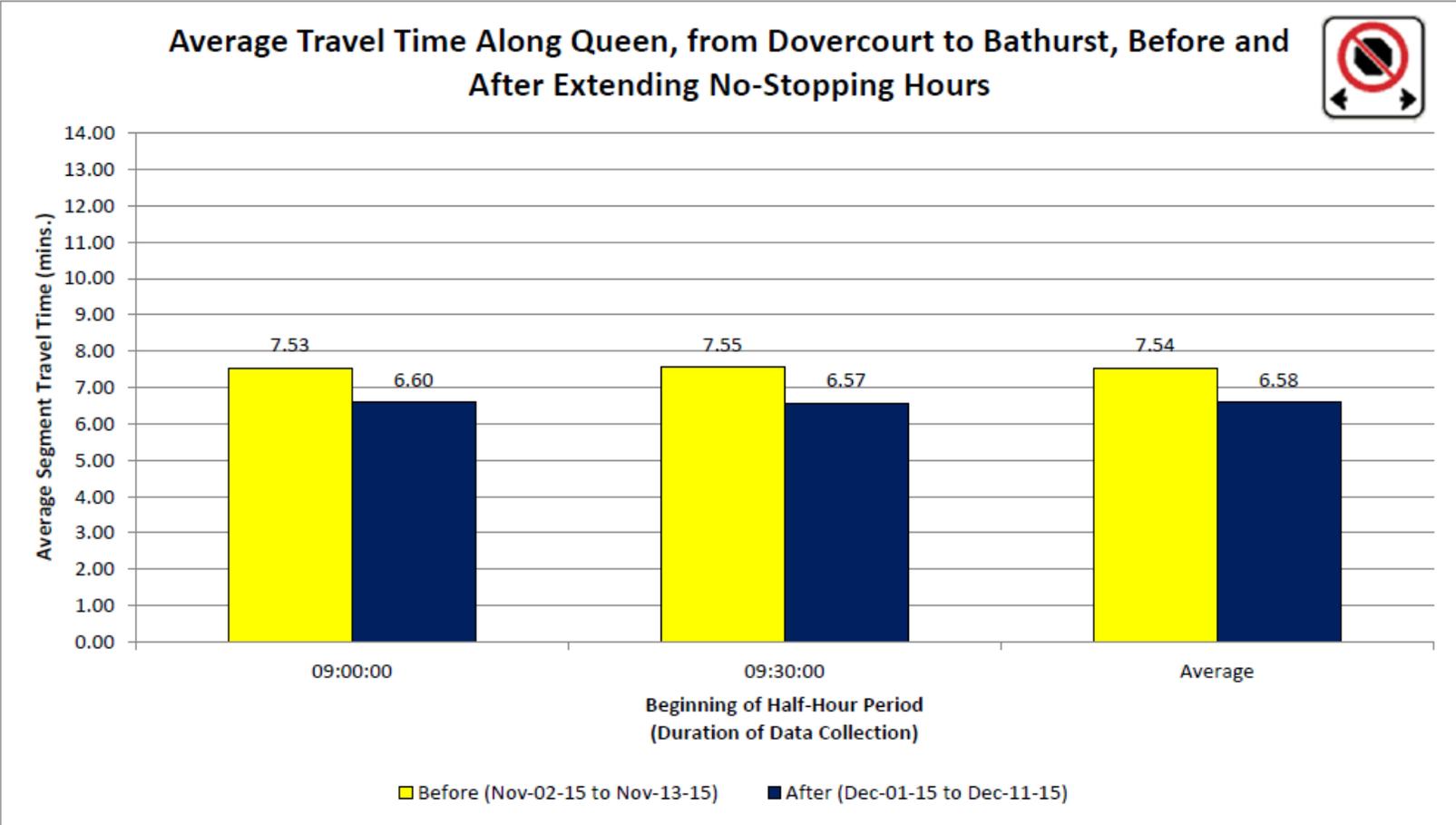
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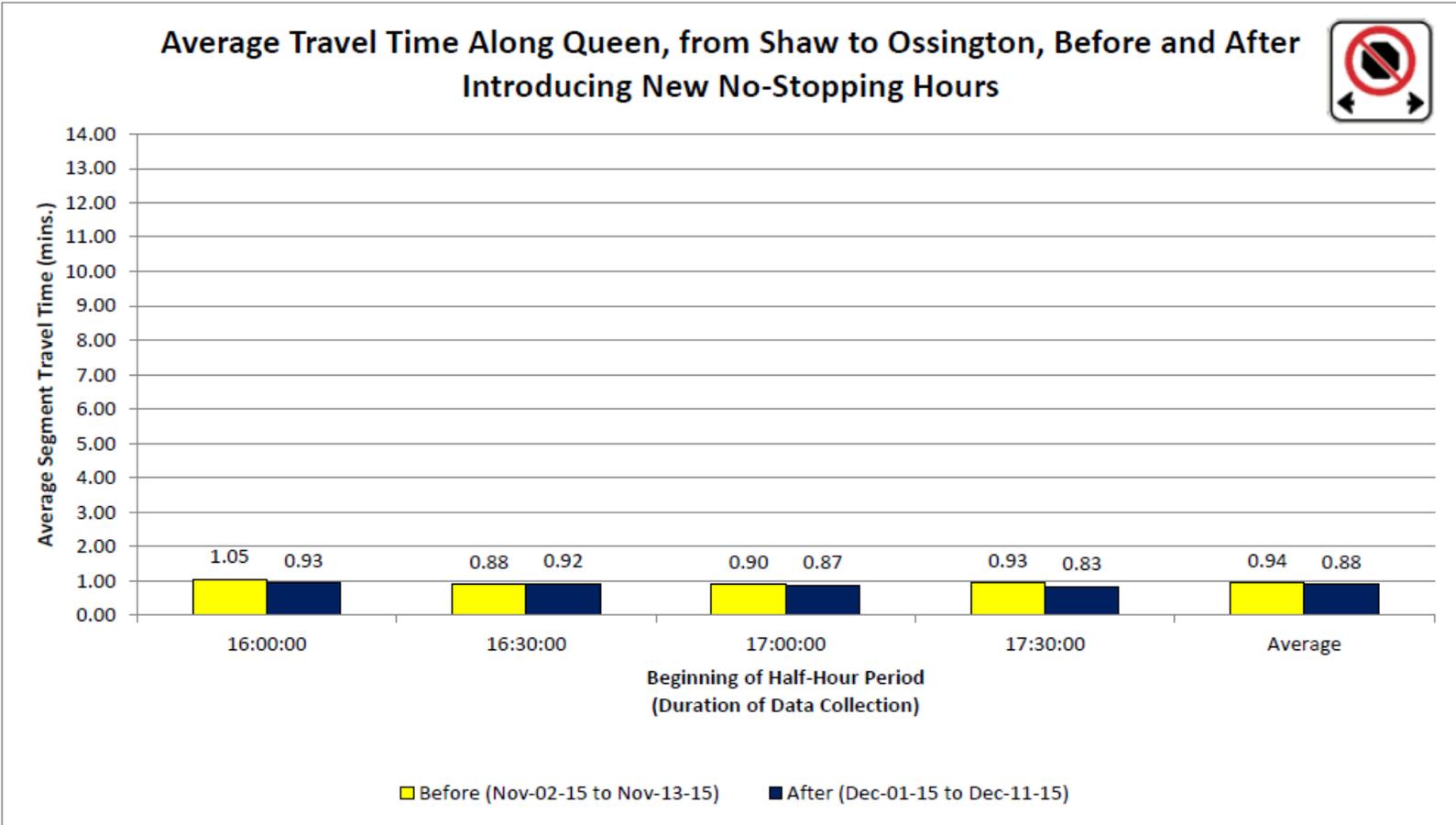
APPENDIX A – 501 Queen Travel Time Comparison
APPENDIX B – 505 Dundas Travel Time Comparison
APPENDIX C – 506 Carlton Travel Time Comparison
APPENDIX D – Scope of Preliminary Study of Streetcars East of Parliament
APPENDIX E – Traffic Regulations to be Amended

APPENDIX A

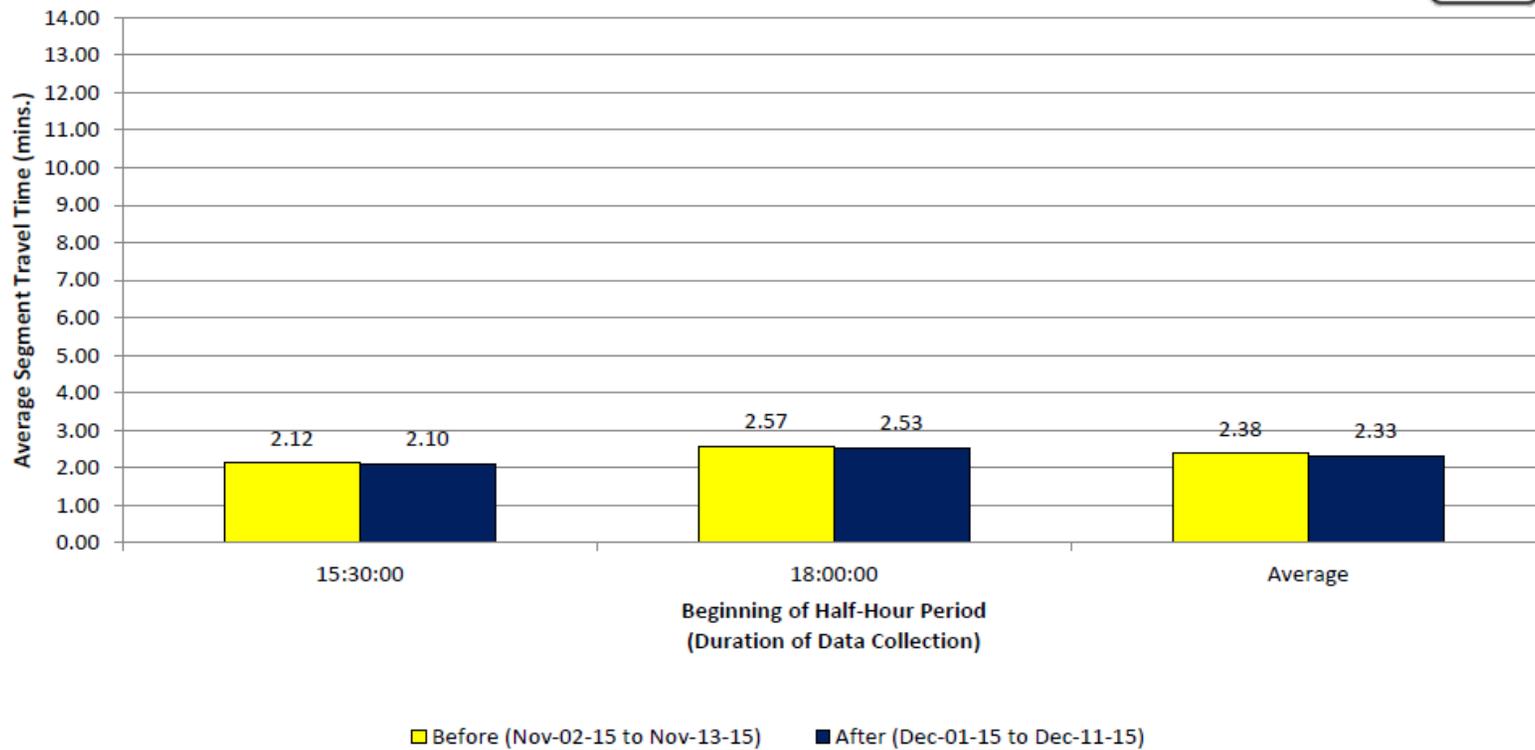
501 Queen Travel Time Comparison





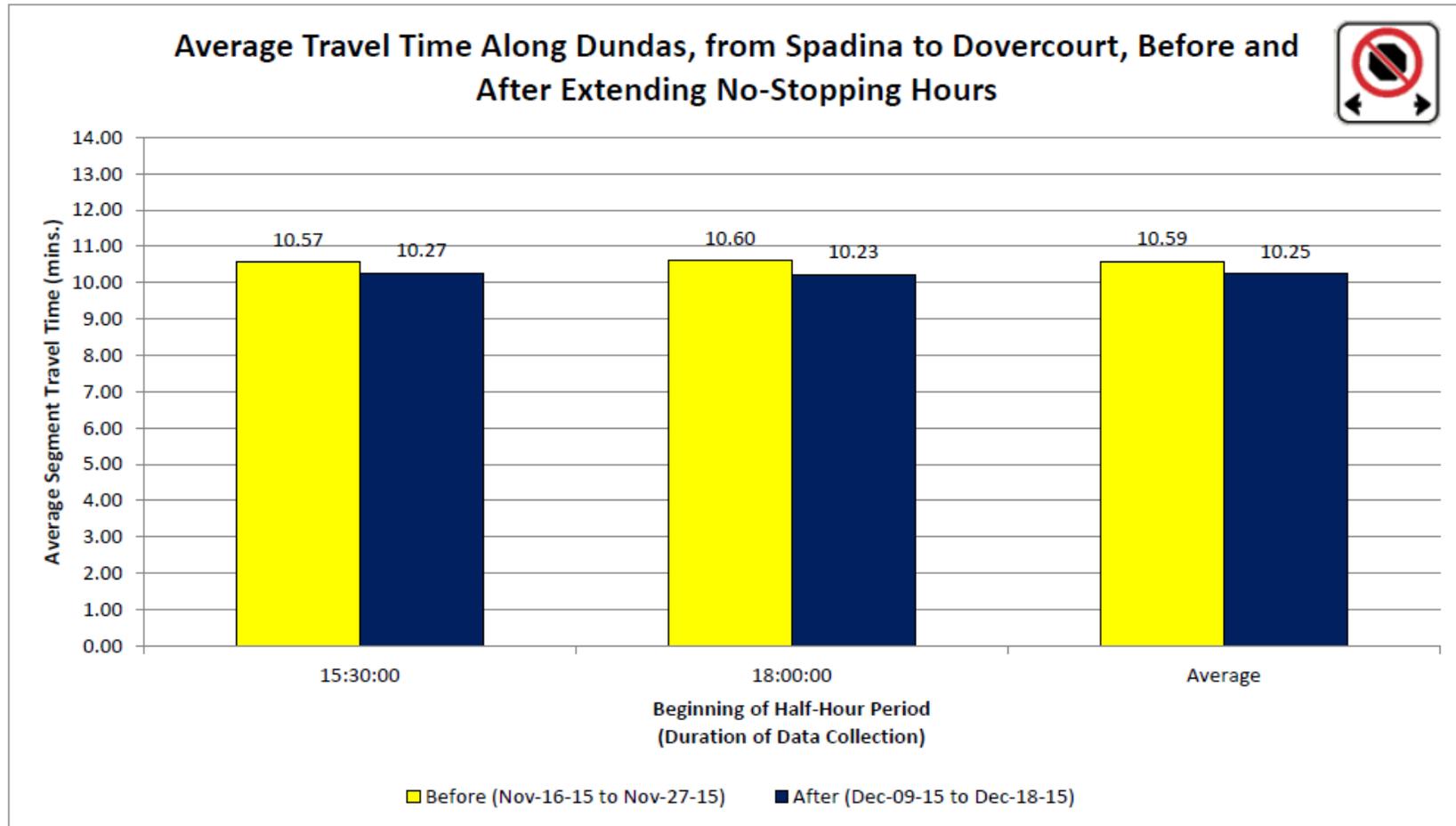


Average Travel Time Along Queen, from Dovercourt to Dufferin, Before and After Reducing the Duration of No-Stopping Hours

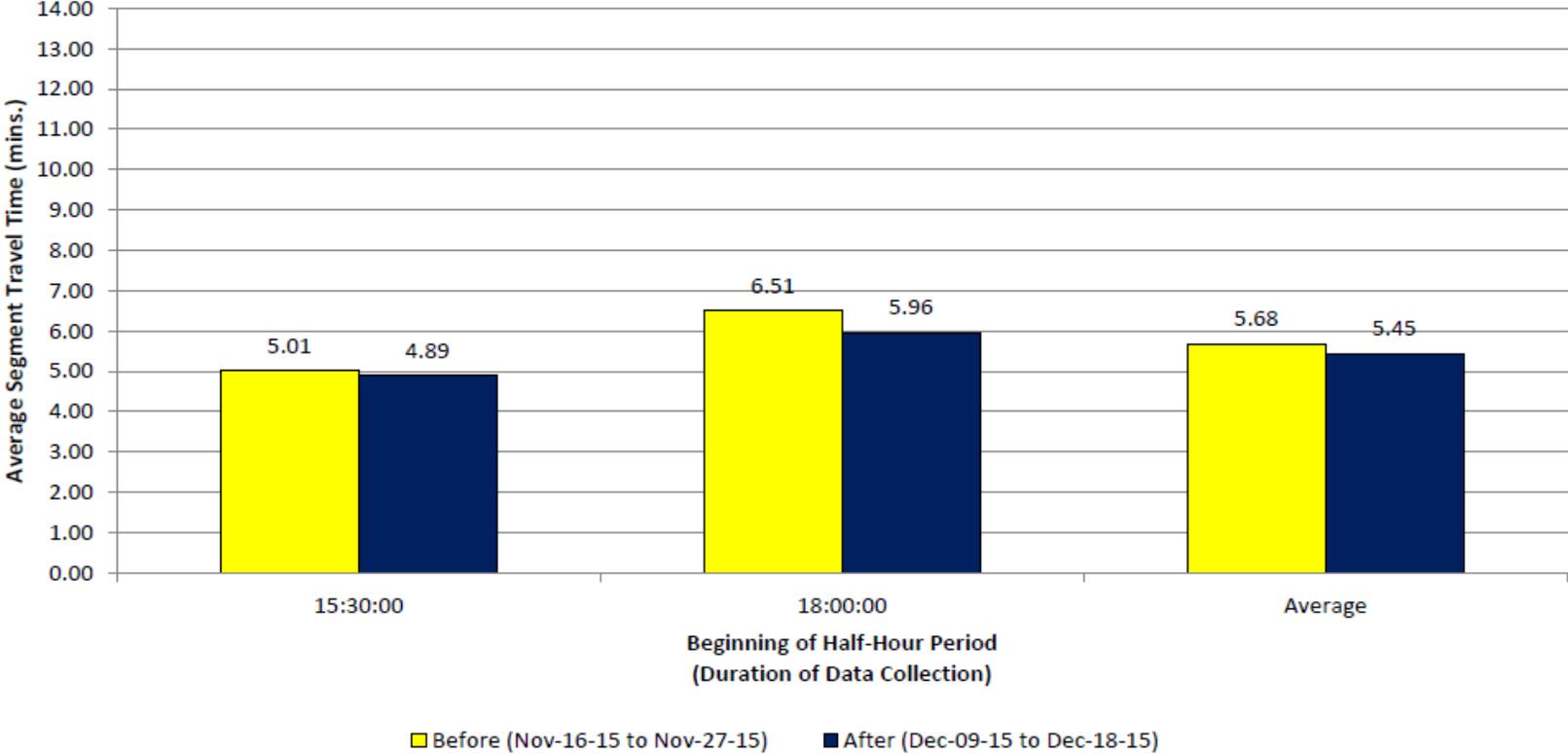


APPENDIX B

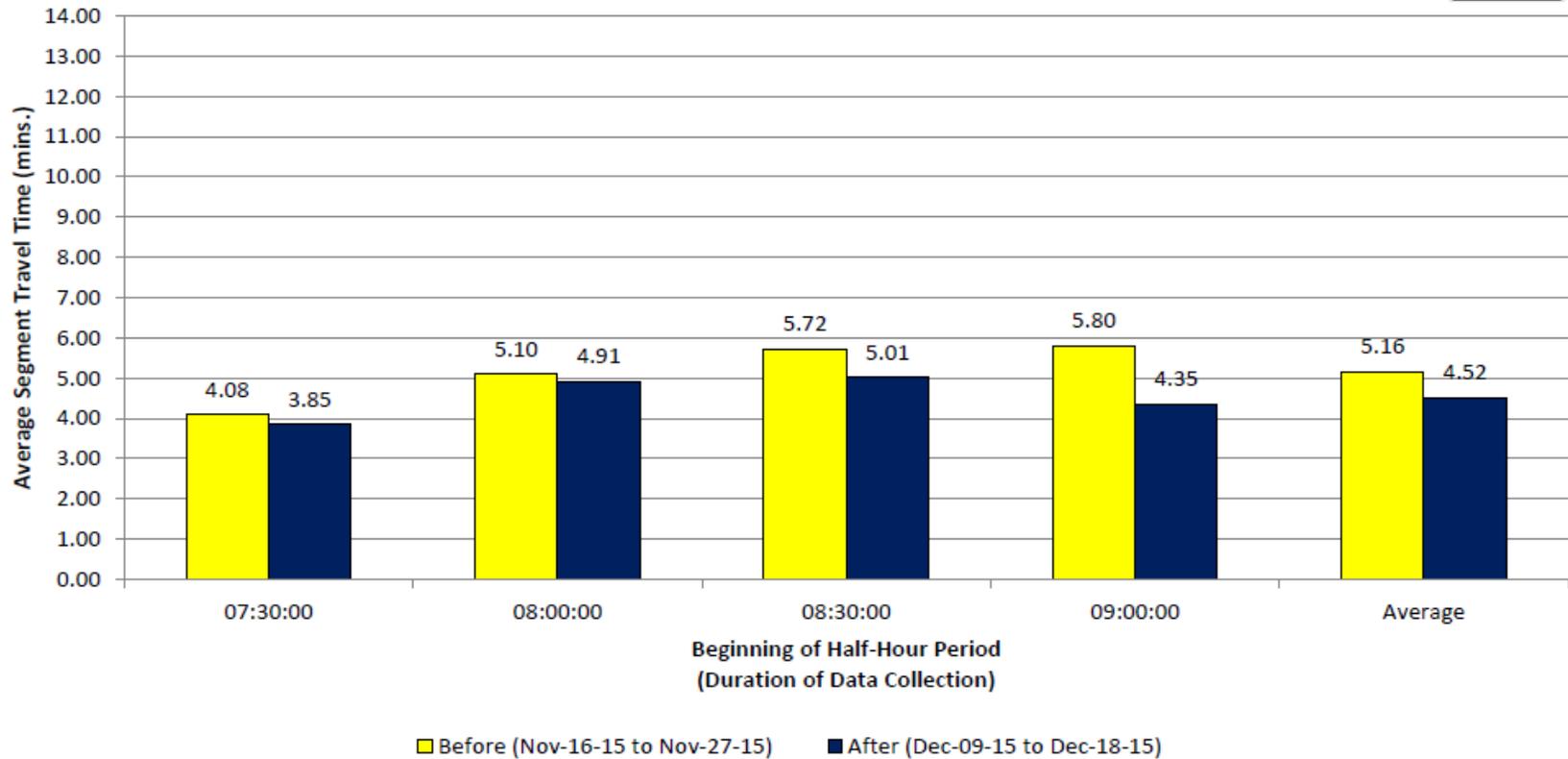
505 Dundas Travel Time Comparison



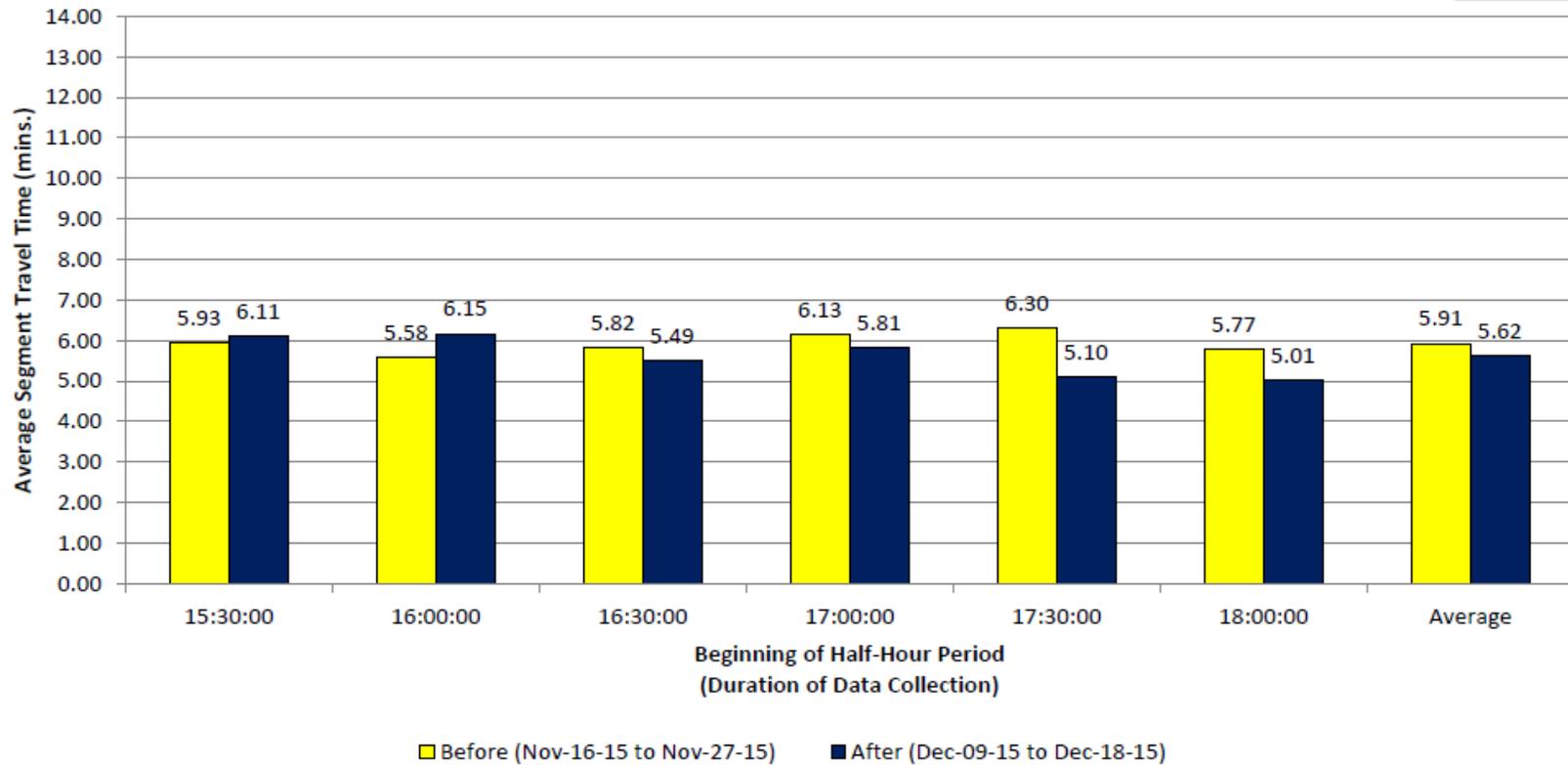
Average Travel Time Along Dundas, from Lansdowne to Roncesvalles, Before and After Extending No-Stopping Hours



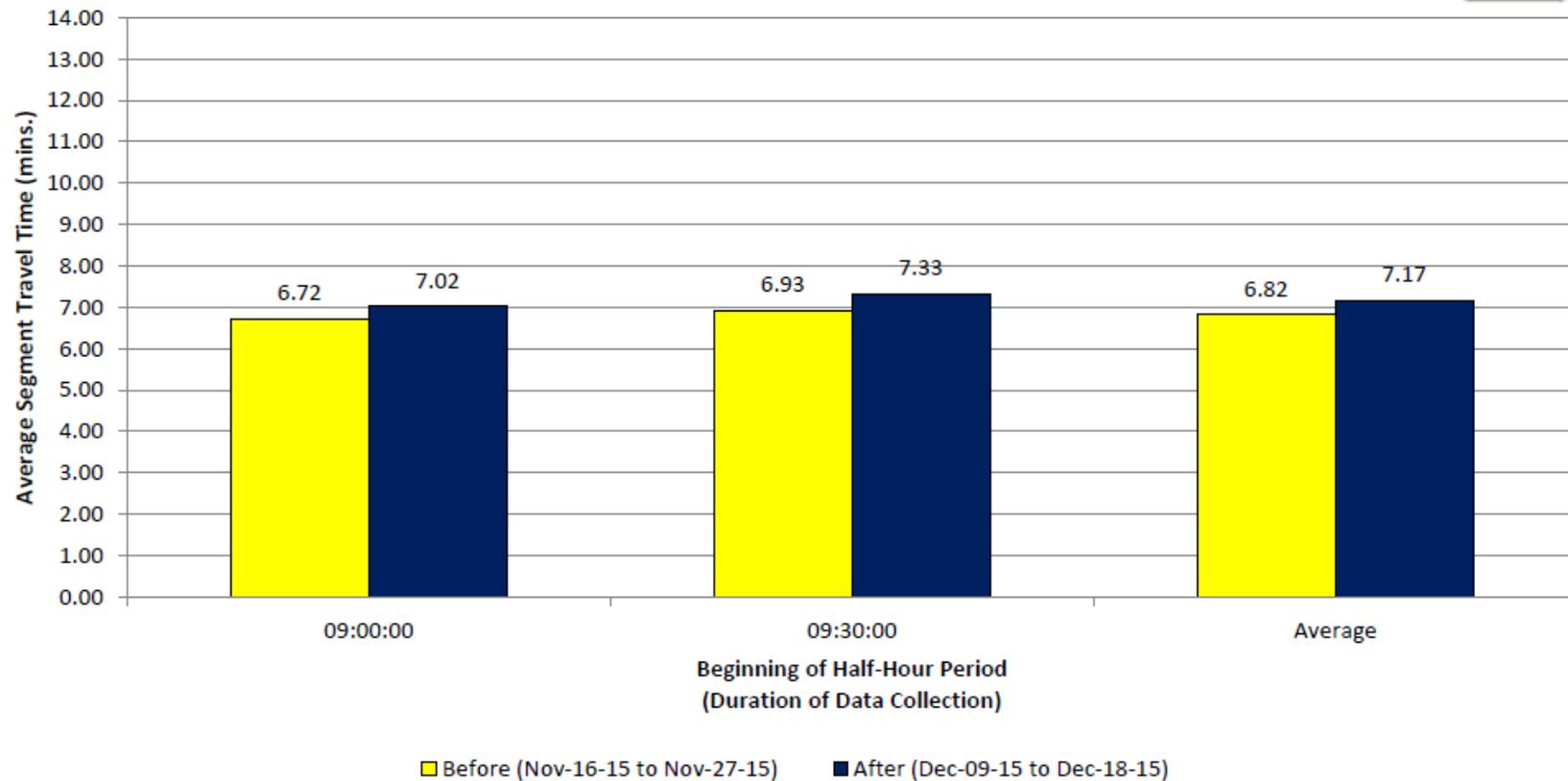
Average Time to Travel Along Dundas, from Spadina to University, Before and After Introducing an EB Left Turn Restriction at Beverley



Average Time to Travel Along Dundas, from University to Spadina, Before and After Introducing a WB Left Turn Restriction at Beverley

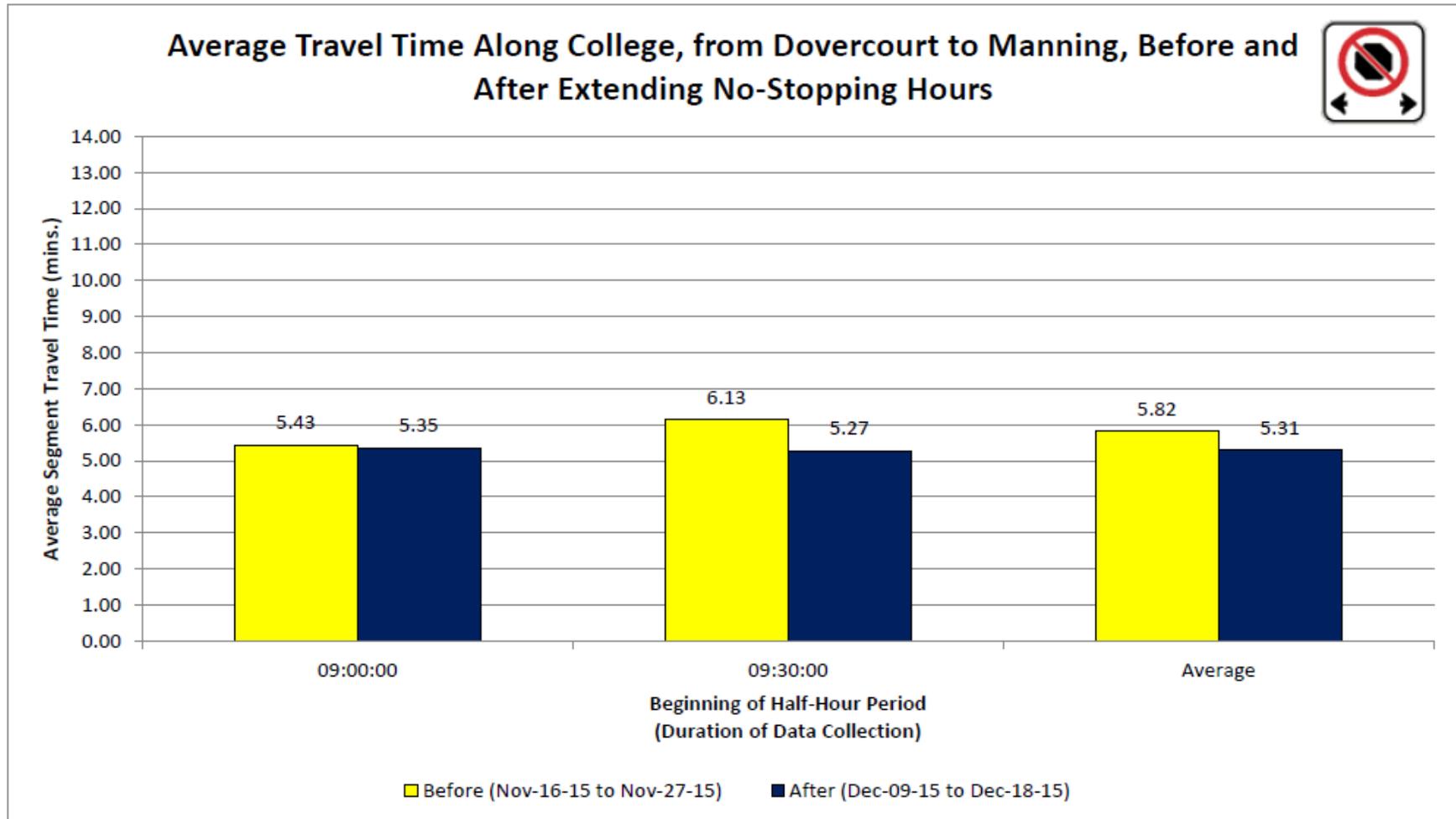


Average Travel Time Along Dundas, from College to Dovercourt, Before and After Reducing the Duration of No-Stopping Hours

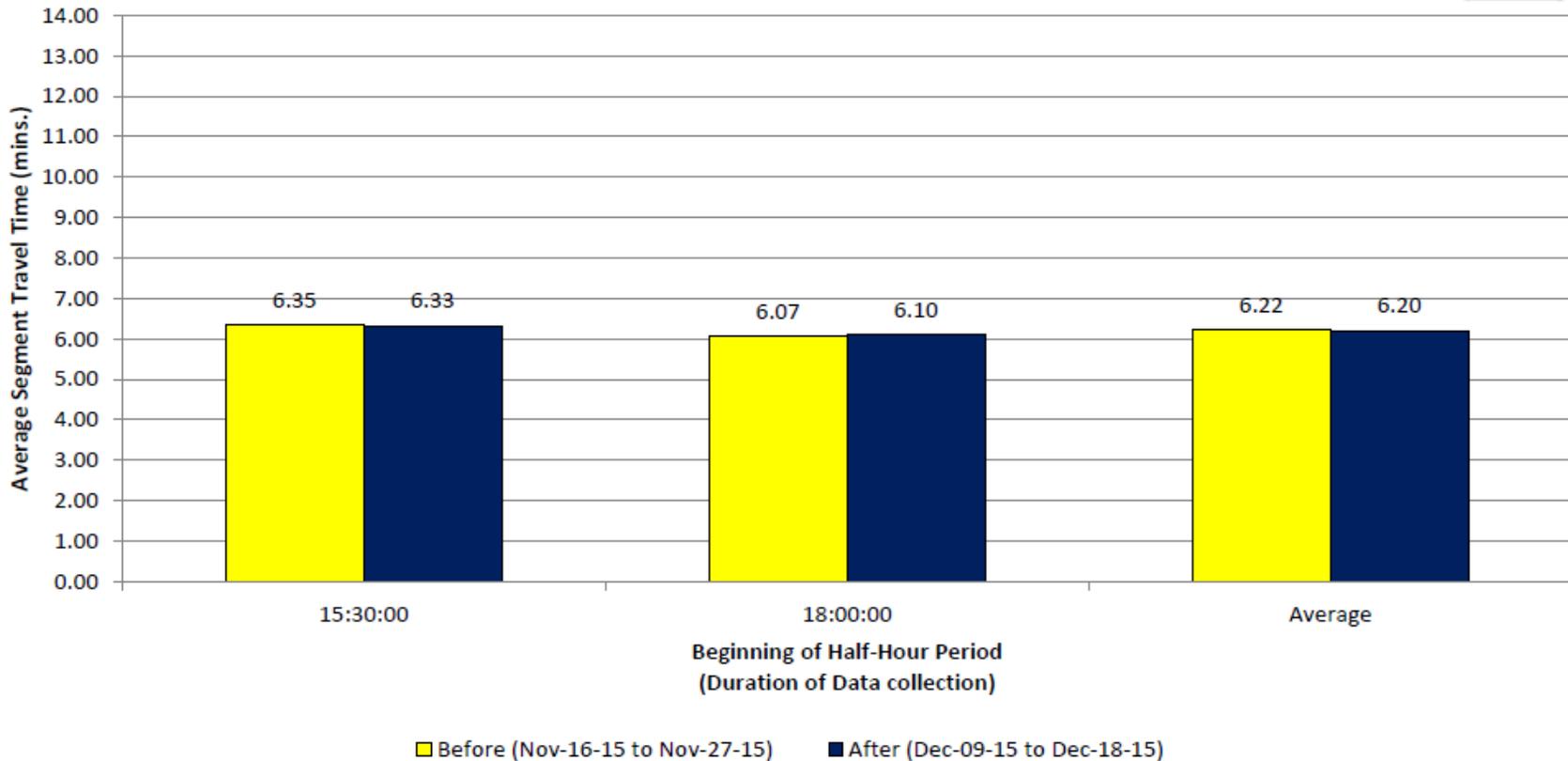


APPENDIX C

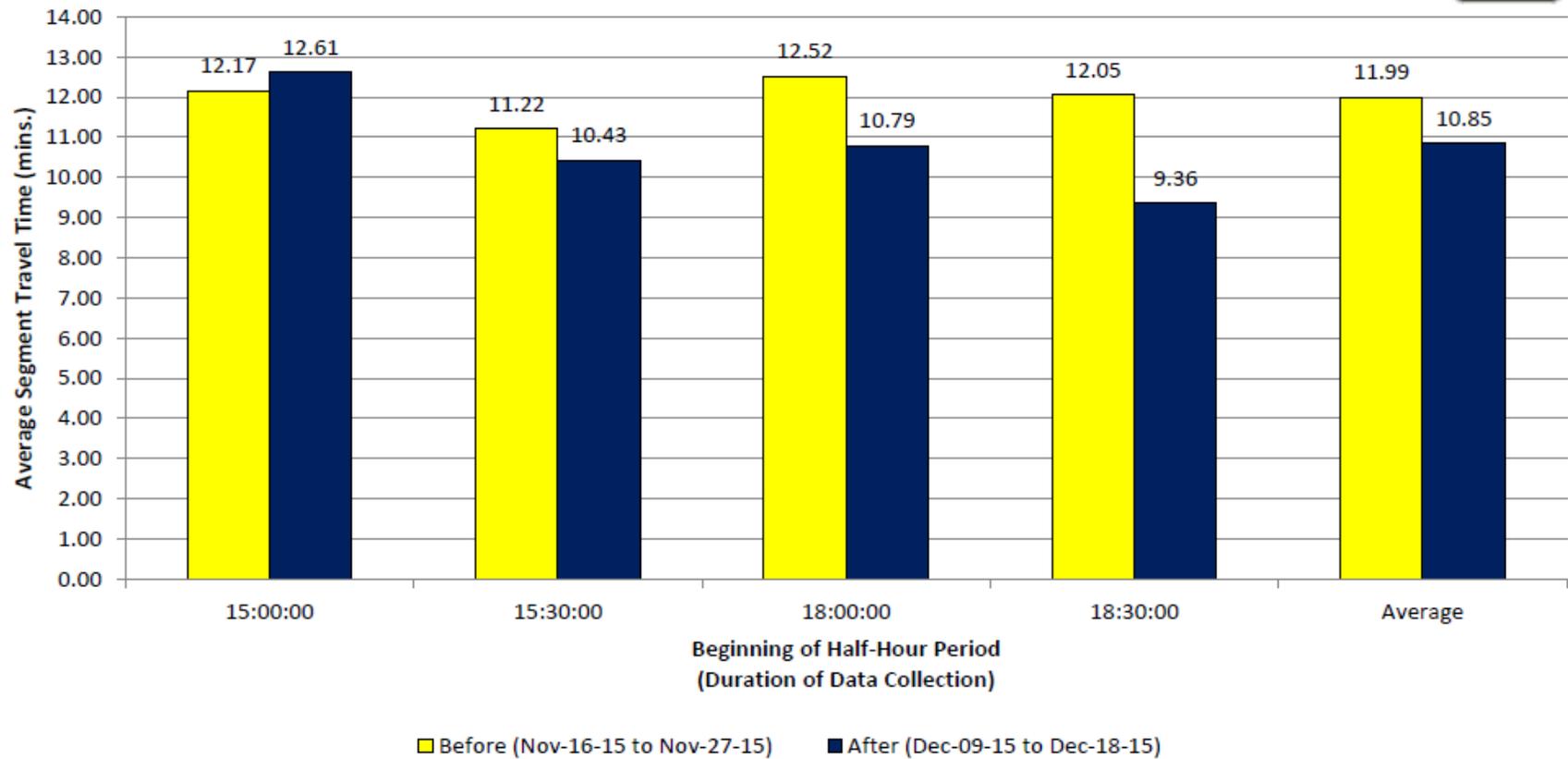
506 Carlton Travel Time Comparison



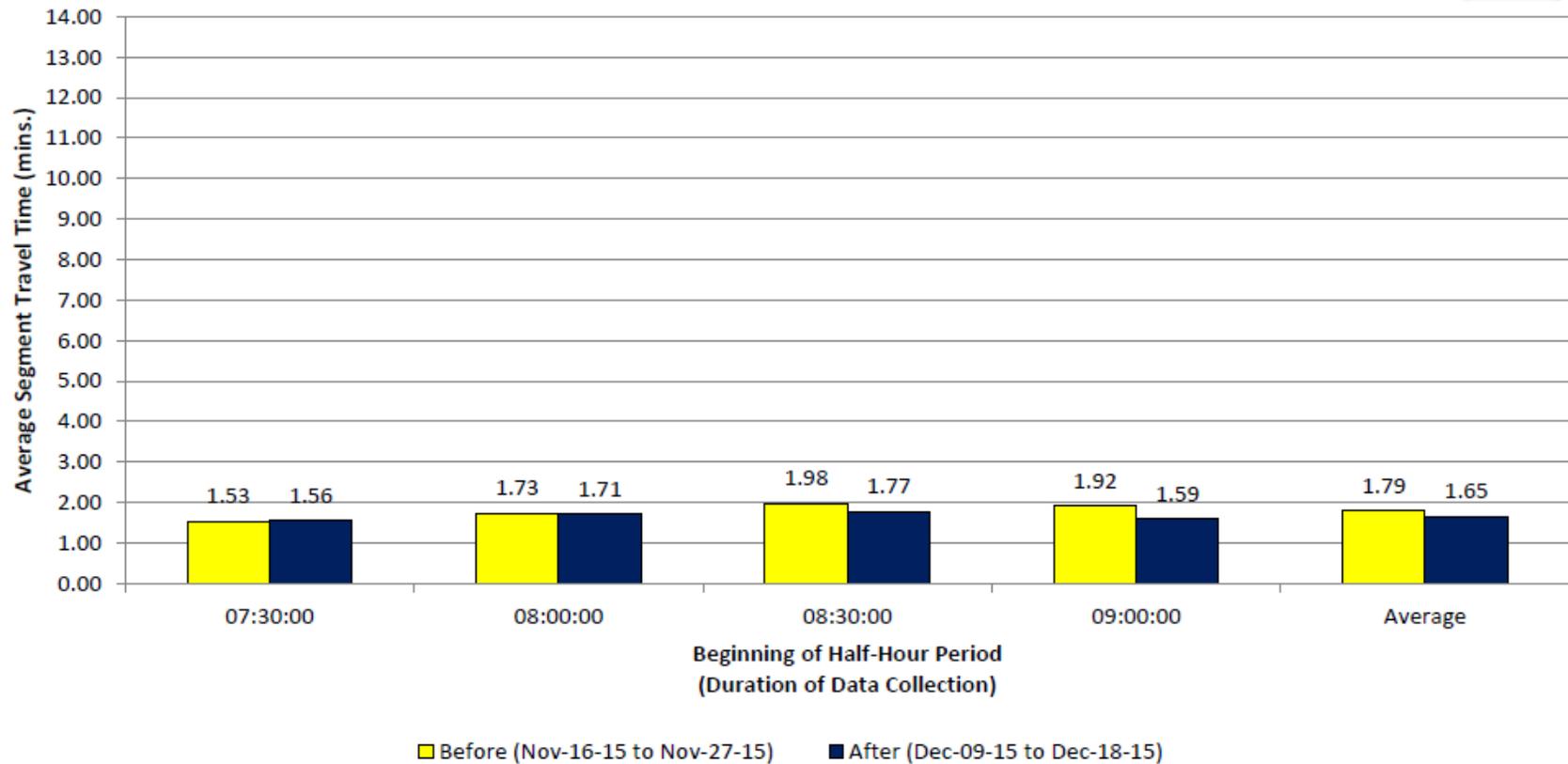
Average Travel Time Along College, from Manning to Dovercourt, Before and After Extending No-Stopping Hours



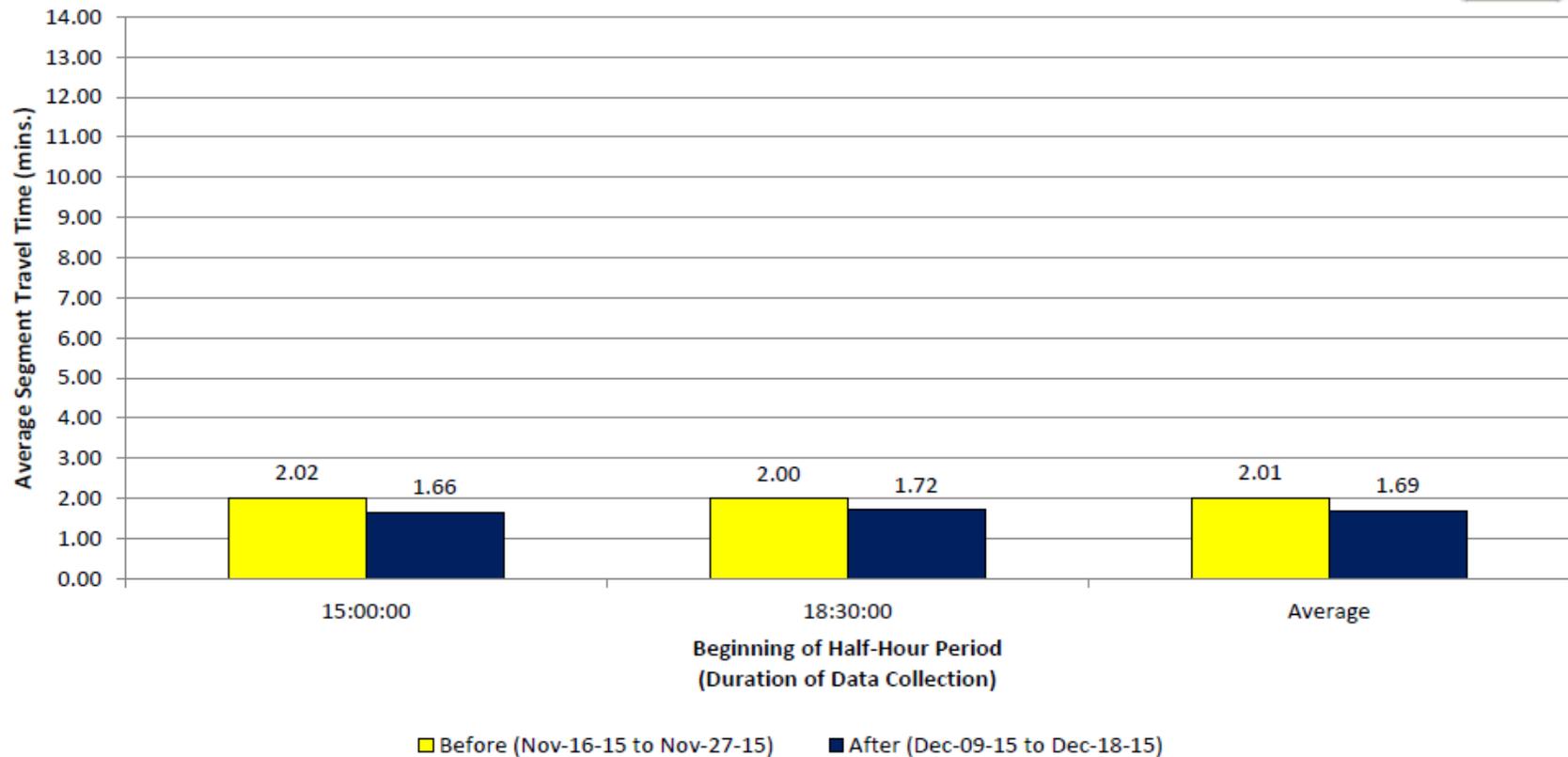
Average Travel Time Along College, from Elizabeth to Parliament, Before and After Extending No-Stopping Hours



Average Travel Time Along College, from Yonge to Bay, Before and After Introducing New No-Stopping Hours

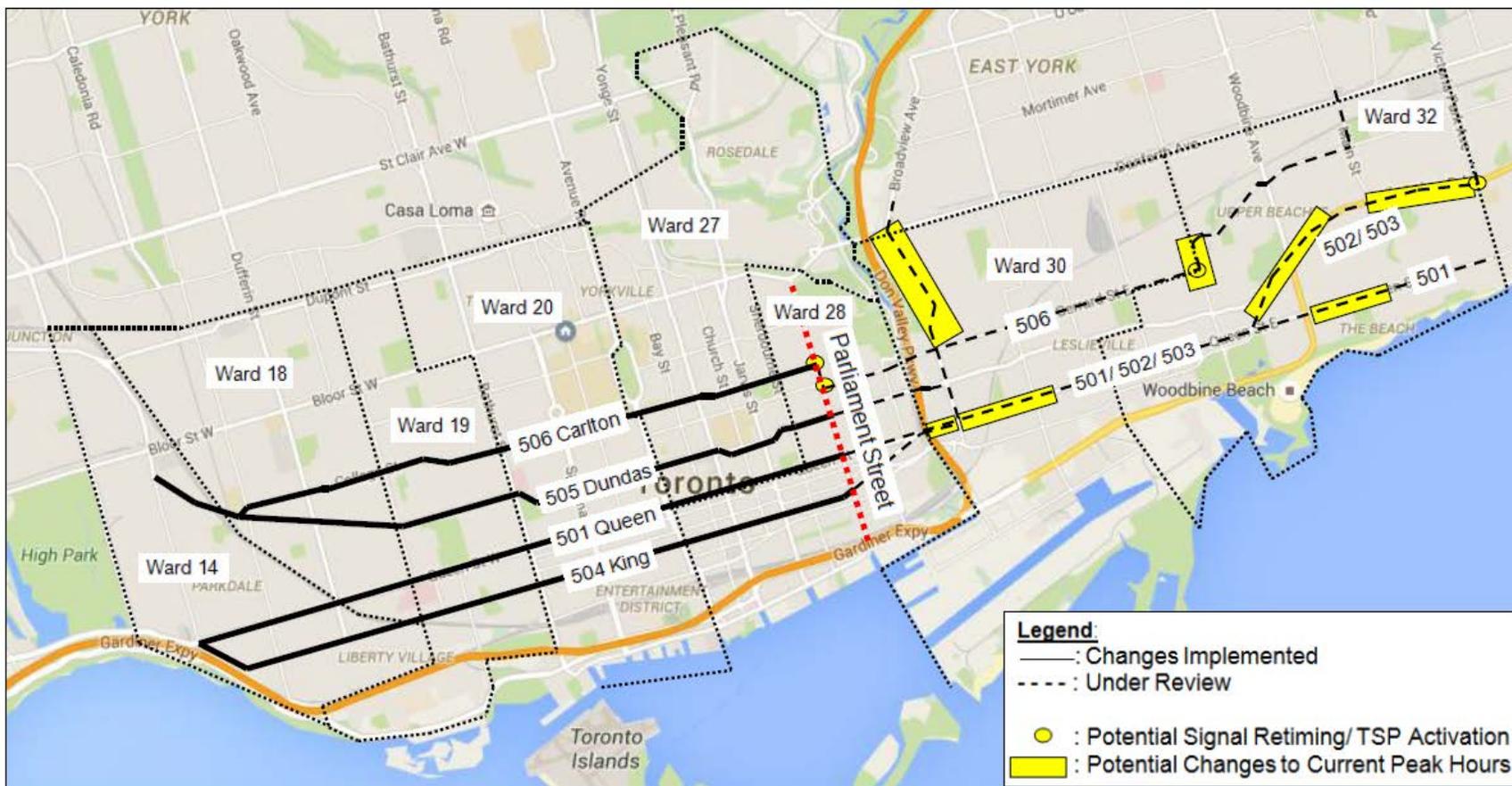


Average Travel Time Along College, from Yonge to Bay, Before and After Extending No-Stopping Hours



APPENDIX D

Scope of Preliminary Study of Streetcars East of Parliament



APPENDIX E

Traffic Regulations to be Amended

Delete from Prohibited Turns the following:

Intersection or Portion of Highway	Direction	Turns Prohibited	Time and/or Days
Queen Street West and Gladstone Avenue [Added 2015-10-02 by By-law No. 1044-2015]	Eastbound	Left	7:00 a.m. to 10:00 a.m. Mon. to Fri., except public holidays