TORONTO

STAFF REPORT
ACTION REQUIRED

King Street Streetcar – Operational Study (Interim Report)

Date:	July 25, 2014
To:	Public Works and Infrastructure Committee
From:	General Manager, Transportation Services
Wards:	Ward 14 (Parkdale-High Park); Ward 19 (Trinity-Spadina); Ward 20 (Trinity-Spadina); and Ward 28 (Toronto Centre-Rosedale).
Reference Number:	P:\2014\ClusterB\TRA\TIM\pw14019tim.docx

SUMMARY

The King Street streetcar is the Toronto Transit Commission's busiest surface transit route carrying approximately 60,000 passengers on an average weekday. Recognizing the importance of this key transit route in the City's transportation system, the General Manager, Transportation Services, was requested by City Council to assess the feasibility and merits of implementing morning rush hour reserved streetcar lanes on King Street in order to improve the service and reliability of the streetcar operations.

This report provides the status of the ongoing data collection, the results of preliminary analysis completed to date, and an outline of the operational improvements currently being considered to improve streetcar service on King Street. A report documenting the final results of this study and any recommended measures to improve streetcar service will be submitted to the Public Works and Infrastructure Committee in 2015.

RECOMMENDATION

The General Manager, Transportation Services recommends that:

1. Public Works and Infrastructure Committee receive this report for information.

Financial Impact

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

DECISION HISTORY

City Council at its meeting on October 8, 9, 10 and 11, 2013, directed "…the General Manager, Transportation Services, to prepare a joint City-Toronto Transit Commission report on the feasibility and merits of implementing morning rush hour reserved streetcar lanes on King Street, including details pertaining to extent/boundaries of the lanes, means of designation or separation of the lanes, means of enforcement, means of monitoring effectiveness of the lanes, cost of implementing such lanes, and effects on other traffic in the corridor, as well as study of traffic management measures to mitigate delays at other pinch-points on the King Street route..." (PW25.15).

http://app.toronto.ca/tmmis/viewAgendaItemHistory.do?item=2013.PW25.15

COMMENTS

Existing Conditions

The King Street streetcar is the Toronto Transit Commission's (TTC) busiest surface transit route carrying approximately 60,000 passengers on an average weekday. With approximately 20,000 motor vehicles also using King Street on an average weekday, the TTC King Street streetcar is often susceptible to delays and variability. To assist in maintaining vehicle speed and reliability, the centre streetcar lanes are primarily 'reserved' for streetcars during the morning and afternoon peak periods in the sections between Dufferin and John Streets, and Jarvis and Parliament Streets. Given the challenges of operating a fixed-track service in a mixed-traffic environment coupled with limited enforcement, the 'reserved' designation provides an imperfect benefit to streetcar service.

In addition, transit signal priority is provided at most intersections. There are also extensive traffic and parking restrictions along this route to improve traffic flow. Despite these measures and restrictions, the TTC King Street streetcar experiences significant delays.

Observed Operational Impacts

An examination of the reserved streetcar lane operations and root causes of delay on King Street has been initiated with the TTC. Among the studies completed to-date is a streetcar speed-delay survey measuring transit vehicle operating speeds and identifying the causes and extent of delay along King Street with a focus on the AM and PM peak periods of 7:00 to 9:00 a.m. and 4:00 p.m. to 6:00 p.m., respectively. This survey was conducted between Jameson Avenue and Berkeley Street over three 'typical' mid-weekdays at the end of February. While these survey days were colder than normal for the time of year, streetcar operations were not negatively impacted by this, snow events, or the presence of the snow on the ground. It is recognized that observed trip times would be expected to be lower (or faster) during the summer when many commuters are away on holidays and demand for travel (i.e., both vehicular and transit) is reduced; except of course during special events like the CNE.

Streetcar Travel Time

The travel time was measured of streetcars passing between signalized intersections and identified the frequency, extent and cause of any delays to the streetcars. The graph in Appendix 1, *Streetcar Travel Time by Peak Period Direction* shows the slowest, average and fastest observed streetcar trips in each direction for both peak periods. The slowest trip was observed to be 42:31 min:sec in the westbound PM direction while the fastest trip was observed to be 23:17 min:sec in the westbound AM direction. Also, on average during all peak periods travel times varied from 30 minutes to over 35 minutes.

While a targeted travel time during a given peak period is desirable, it is the variability between the fastest and slowest trips in any peak period (observed to be as much as 14:11 min:sec during the westbound AM) that causes the greatest disruption to reliability of TTC service. In situations like this, while trying to maintain adequate spacing between vehicles, streetcars will bunch together resulting in periods where there are multiple streetcars in a row and then none for a much longer period of time. In an attempt to address the gap in time created and improve service, TTC supervisors along the route will re-route (i.e. short-turn) some streetcars from the opposite direction to fill the gap.

Travel Speed in Reserved Lanes

In Appendix 2 entitled *Reserved vs. non-Reserved Lane Travel Speed by Peak Period Direction*, it shows streetcar travel speed on the two reserved lane segments (3.8 km. in length) as compared to the two segments without reserved lanes (2.2 km. in length). Specifically, the segment with the slowest average travel speed was the 1.5 km, John to Jarvis Streets stretch eastbound during the PM peak period (8.1 km/hr). The segment with the fastest average travel speed was the 500 metre, Jarvis to Berkeley Streets, stretch eastbound during the AM peak period (18.2 km/hr). Across all peak periods, the slowest segment was John to Jarvis Streets varying between 8.1 km/hr and 10.7 km/hr. While a glance at this graph would suggest that introducing reserved lanes in the slowest stretch (i.e., John to Jarvis Streets) might increase average streetcar travel speeds, a detailed examination of the data shows that there is more going on. In a congested downtown core area, there are frequent instances of traffic flow interrupted by taxis and illegal stopping activity occurring curbside. Also, it is impractical to operate Transit Signal Priority at four key intersections, as will be explained later in the report.

Causes of Delay

To gain a better understanding of the causes of delay, a number of factors were examined by way of survey. In the survey, delay was recorded to have occurred if the streetcar was observed to be operating at less than 5 km/hr (walking speed). The graph in Appendix 3, *Causes of Delay by Peak Period Direction*, shows the causes of all measured delay namely: Passenger Service Time; Traffic Control Signal delay; Congestion delay; and Other.

Passenger Service Time (PST) is the time serving passengers loading and unloading at streetcar stops. Traffic Control Signal (TCS) delay is the time incurred at a signalized intersection, including the red signal and the time it took for the vehicles ahead of the streetcar waiting at the signal to clear out of the way. Congestion delay is that time not attributed to a signal, left- or right- turning vehicles ahead of streetcar, or transit vehicle ahead servicing passengers. All other delay was combined into the category 'Other' and includes that time due to left- turning or right- turning vehicles ahead of streetcar, transit vehicle ahead servicing passengers, or other related rare instances.

As shown in Appendix 3, PST is the greatest cause of delay for all peak period directions; contributing over half of the delay in the eastbound peak period directions and just under half of the delay in the westbound peak period directions. Specifically, PST during the average trip was as little as 4 minutes of the almost 10 minutes of total delay occurring during the westbound AM peak period. The PST was as much as 7 minutes of the approximately 15 minutes of total delay occurring during the westbound PM peak period. It is understood that the TTC are working to reduce PST with the introduction of new streetcars and service protocols, as will be discussed further at the end of this report.

Of the remaining contributors to slowing streetcars over the peak periods, 'TCS' delay contributes between 30-40% (i.e., approx. 4 minutes), 'Congestion' delay around 10-20% (i.e., approx. 1-3 minutes), with 'Other' delay causes around 1-9% (i.e. less than half a minute). To further understand TCS delay in the context of the current transit signal priority (TSP), the graph in Appendix 4 entitled *Traffic Control Signal Delay by Transit Signal Priority (TSP) Status Type for Peak Period Directions* illustrates the current impact of TSP and is discussed further below.

Transit Signal Priority Impact

The purpose of TSP is to reduce delay to streetcars at signals. Specifically, the King Street TSP is activated when a streetcar approaches an intersection equipped with TSP signal control, and is detected by the traffic signal controller's loop in the roadway. Once the streetcar is detected and if the traffic signal shows 'green', the controller is instructed to both 'hold' the signal light, in the direction of the 'green' up to 30 seconds and cancel this 'hold' once the streetcar enters the intersection. While a 30 second 'hold' is generous by industry standards, the TTC advises that the full extension is rarely called upon, nor required, to move the streetcar through an intersection.

The controller can also be called upon to extend the left-turn phase at some intersections (i.e., westbound approaching Jameson Avenue and eastbound approaching Bathurst Street)

so as to clear the lane to allow the streetcars to approach its stop. Though TSP allows approaching streetcars facing a 'red' light to also shorten the available 'green' time in the cross-traffic direction, this truncation often does not exceed 5 seconds in order to provide adequate, safe pedestrian 'green' crossing time during the signal's countdown phase.

The graph in Appendix 4 illustrates the impact of four TSP conditions (or Types) that occur along the corridor and the extent to which the signal delay has occurred at intersections with that TSP type. The four TSP types are: 'Full', 'Moderate', 'TSP disabled' and 'No TSP'. 'Full' and 'Moderate' represents those intersections that are TSP-enabled and capable of extending the traffic control 'green' signal up to 30 and 16 seconds, respectively. 'TSP disabled' represents those intersections that normally operate with TSP control but at the time of the survey, did not have TSP in place due to a faulty loop or controller undergoing repair or replacement. 'No TSP' represents those intersections that simply do not have TSP in place.

Of all the intersection approaches along King Street, 18 in each direction (72%) had 'Full' or 'Moderate' TSP in place. A breakdown of TCS delay by peak direction reveals average trip delay varying from 208 seconds in the eastbound AM peak to 261 seconds in the westbound PM peak at these intersection Types. The remaining seven intersections had either no TSP or TSP was disabled; these intersections alone comprised between 52% and 70% of the delay at all signalized intersections over the peak periods.

The graph in Appendix 5 entitled *Average Delay by Intersection Approach Traffic Signal Priority Type* details the following. The four 'No TSP' intersections experienced an average of 23 to 26 seconds of delay per intersection across all peak period directions. This delay is substantial and is addressed in further detail in the next section. The three 'TSP disabled' locations experienced approximately 11 to 15 seconds of delay per location. While this is significant, it is expected that once they are re-enabled, this delay will be reduced.

At the 'Moderate' TSP intersections, the average delay ranged from 8 to 18 seconds in the eastbound direction (i.e., one location), and 8 to 14 seconds in the westbound direction (i.e., three locations). At the 'Full' TSP intersections, the average delay at the 17 eastbound locations ranged from 3 to 4 seconds, while the average of the 15 westbound locations was around 5 seconds. Given that intersections with 'Full' TSP are generally the least congested, it is not surprising that average delays were low. As for intersections with 'Moderate' TSP, the extent of this delay is also expected, as these locations have significant cross-traffic that would be substantially impacted if a longer TSP extension was made available for streetcars.

Operational Improvements Under Consideration

Intersections without TSP Control

It is recognized that the biggest traffic control signal related delay to a streetcar travelling along King Street, occurs at those intersections currently without TSP; namely, Spadina and University Avenues and Bay and Yonge Streets. While it might seem that introducing TSP at the above intersections would provide the same benefit for streetcars as all other intersections with TSP, any extension of 'green' signal time in the TSP direction of travel will delay the occurrence of the 'green' signal for cross-traffic. Unlike minor intersections where this is often just a slight inconvenience to motorists, at major intersections signal timing adjustments would have to be made over subsequent signal cycles to make up for the delay with consideration for cross-traffic flow and corridor signal progression. At the busiest times of day, this could only be accommodated over a much longer period of time.

In addition, the TTC has noted that TSP control at any of the above four intersections is not a consideration, because lengthy and highly variable passenger service times there would likely not improve service. In fact, passenger boarding times would likely be longer than the additional 'green' signal time provided by TSP, leading the vehicle to miss the opportunity to pass through the intersection. This would cause unnecessary delay for cross-traffic, while extending the stop time at the intersection, as passengers would be boarding on an extended 'green' signal instead of a 'red' signal. At this time, the TTC acknowledges this issue and would be prepared to revisit the introduction of TSP control at these locations once the new streetcars are in operation and there is an expectation of substantial reductions in the length and variability of passenger service times. Further at this time, consideration could be given to introducing new technologies, such as having a communication link to the TSP controller that, would terminate a signal extension when doors open, so that streetcars would then load on the red signal.

Improving TSP Operation

As sophisticated and accommodating TSP is to the facilitation of streetcar flow, the current system can be improved. Among the measures to be considered include:

- Modifying the algorithm (i.e., rules triggering the action) on which TSP is based to reflect the latest state-of-the art knowledge and respond to the varied and dynamic nature of traffic flow stemming from the City's complex urban setting;
- Assessing the opportunity to convert 'Moderate' TSP locations, with up to 16 second extensions, to 'Full' TSP control, with up to 30 seconds. Conversely, considering whether intersections with 'Full' TSP control may serve all traffic better if the extension was limited to only 16 seconds, can be examined;
- Considering the introduction of new technologies like GPS sensors that can detect when a vehicle has passed a previous intersection or other set-points along the route, and influence the controller ahead; and
- Reviewing detector loop locations with a view to optimize operation.

Staff will continue to work with TTC staff to re-evaluate improvements in these areas. Any modifications considered would have to weigh the benefits to streetcar operations against those impacts experienced by traffic, including pedestrians and cyclists.

New TTC Streetcars

With the TTC taking delivery of new, longer (30 metre vs. 15 metre) streetcars and introducing them on King Street in 2017, overall service is expected to improve. With that, the largest single contributor to delay to streetcars (i.e., passenger service time) will be significantly reduced. The introduction of a proof-of-payment system with loading and unloading at all doors of these low-floor vehicles will result in reduced passenger service times at stops. The higher capacity of these streetcars coupled with service frequency adjustments will reduce the incidents of streetcar bunching and the resultant need for short-turning some vehicles. This may allow transit signal priority to work more effectively. Despite being larger (and heavier), the new streetcars will maintain the same acceleration and stopping characteristics as the existing streetcars. Staff are working with the TTC to ensure a smooth transition to new streetcar implementation.

Other Improvements

Staff will be examining the survey results in greater detail and conduct additional surveys as necessary to determine what improvements should be considered to further improve streetcar service and reliability. These include, but are not limited to, the following:

- Further adjust traffic signal timings;
- Examine ways to enhance the operation of the existing 'reserved' streetcar lanes;
- Review transit stop locations and consider removal of redundant or very-low volume stops;
- Improve compliance through stepped-up enforcement blitzes and tows, as necessary, especially along 'reserved' lane sections;
- Install cameras to monitor issues;
- Explore real-time traffic monitoring tools, like geographic positioning systems (GPS) data, and explore the ability to respond to location-specific problems;
- Implement light-emitting diode (LED) time-of-day turn prohibition signs at key locations to improve visibility for motorists; and
- Consider additional turn prohibitions.

Spatial and Temporal Delay Analysis

In June 2014, Transportation Services and TTC retained a consultant to analyze streetcar operations on King Street using TTC's automated vehicle locator (AVL) data. The project will explore the travel times and reliability of the 504 King streetcar route between Parliament and Jameson, with detailed investigation of different segments of the route. This analysis will be different than the speed-delay study discussed in this report, in that it will be undertaken with a less-detailed but much larger sample of TTC runs over a larger part of the day over a six-month window. Specific questions under investigation are:

- How do peak vs. off-peak travel times vary at different locations on the route?
- What locations are least reliable and most subject to delays?
- How have different incidents and events (e.g. construction, storms) affected streetcar operations during the study period?
- How did recent changes to peak hour parking and turning restrictions on King Street affect streetcar operations?

While it is too early to report on the conclusions, it is expected that the results of this project will be shared once they are available. The project will inform future Transportation Services and TTC efforts to improve surface transit operations through changes to traffic operations, parking and turning regulations, enforcement, construction management, infrastructure modifications, among others and will serve as a model for future evaluations on other key transit corridors.

The results of all of the above will be reported to the Public Works and Infrastructure Committee in 2015.

Recent Operational Improvements Adopted by Council

In early March, extended peak period parking and associated turning restrictions were introduced on portions of King Street, and other downtown area streets, as a congestion management measure contained within the Downtown Transportation Operations Study (DTOS) deliberated at Council in December 2013. The restrictions now extend from 7:00 a.m. to 10:00 a.m. in the morning and from 3:00 p.m. to 7:00 p.m. in the afternoon to keep streetcars and other vehicles moving during these periods. It is anticipated that these changes will be implemented by the end of 2014.

In addition, City Council on July 8, 9, 10 and 11, 2014, approved "…the extension of the hours of the traffic and parking regulations on King Street between Bathurst Street and Roncesvalles Avenue to encompass 7:00 a.m. to 10:00 a.m. and 3:00 p.m. to 7:00 p.m. as contained in Appendix 2 of the report (June 2, 2014) from the Director, Transportation Infrastructure Management, Transportation Services." In addition, Council requested "…the General Manager, Transportation Services to review the proposal to amend traffic and parking peak period regulations on King Street East, east of Jarvis Street, and submit a further report to Toronto and East York Community Council."

http://app.toronto.ca/tmmis/viewAgendaItemHistory.do?item=2014.TE33.75

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SIGNATURE

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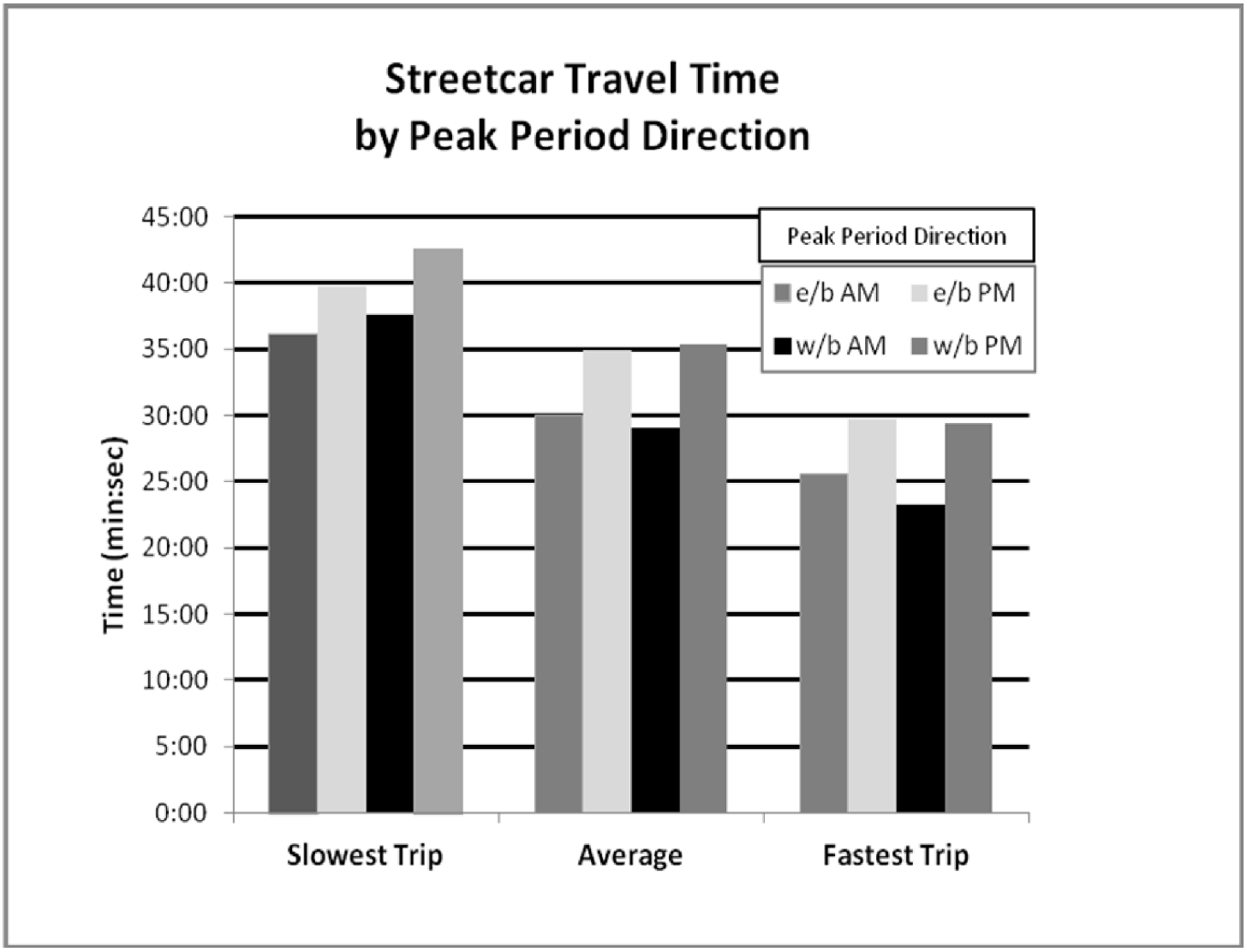
Stephen Buckley
General Manager, Transportation Services

PAS/ps

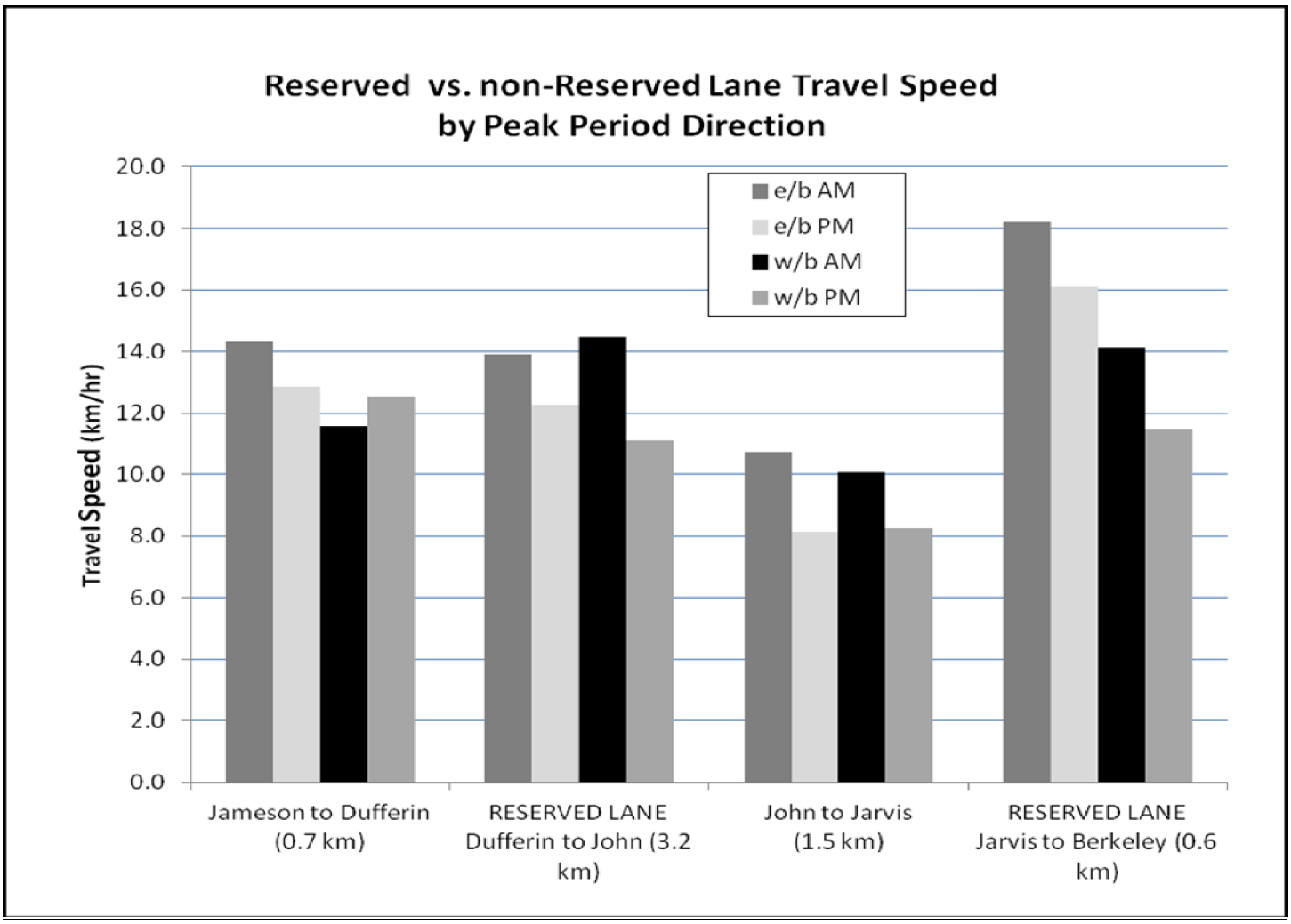
ATTACHMENTS

APPENDIX 1 – Streetcar Travel Time by Peak Period Direction
APPENDIX 2 – Reserved vs. non-Reserved Lane Travel Speed by Peak Period Direction
APPENDIX 3 – Causes of Delay by Peak Period Direction
APPENDIX 4 – Traffic Control Signal Delay by Transit Signal Priority (TSP) Status Type for Peak Period Directions
APPENDIX 5 – Average Delay by Intersection Approach Traffic Signal Priority Type

APPENDIX 1

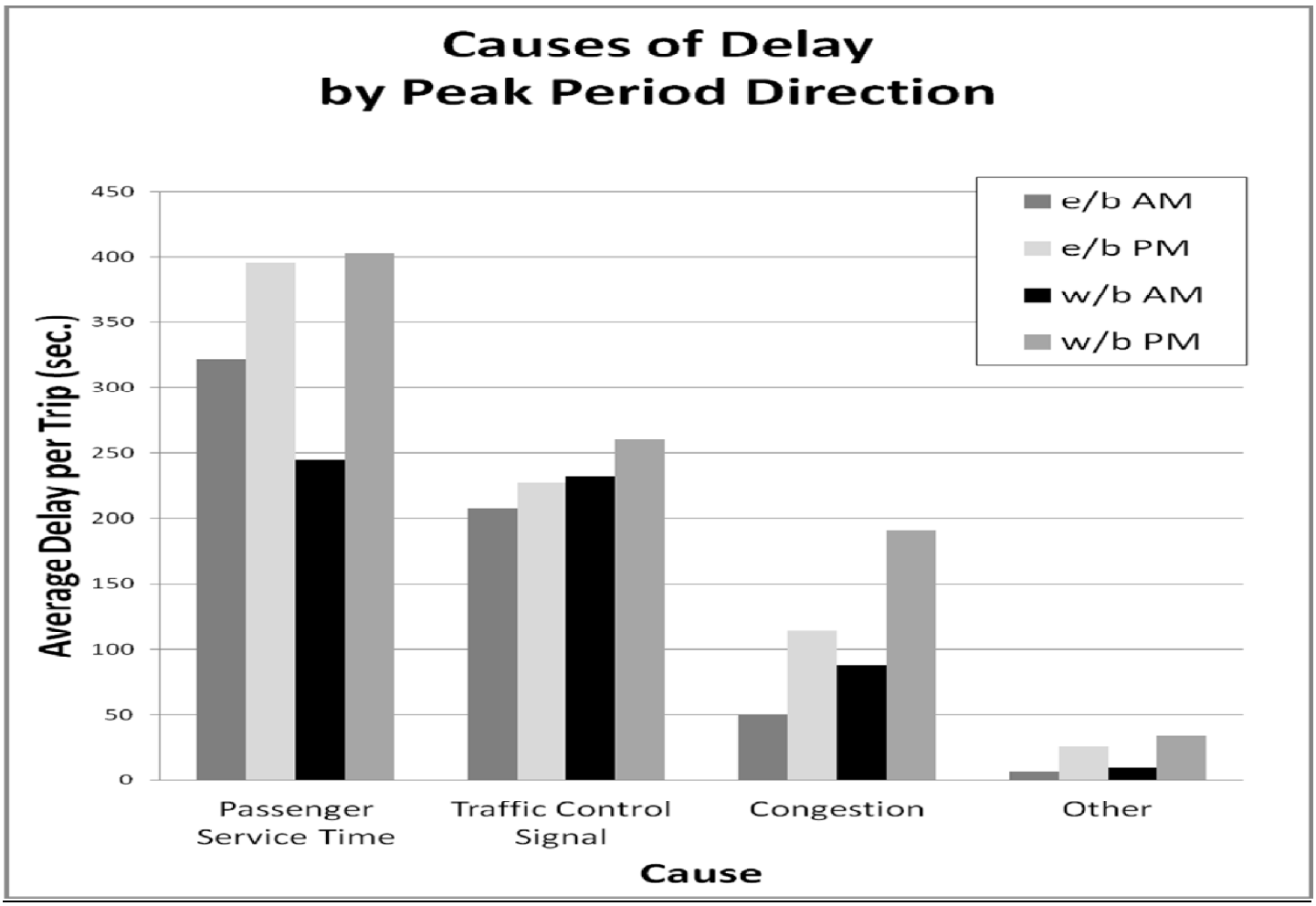

Streetcar Travel Time
by Peak Period Direction
Time (min:sec)
45:00
40:00
35:00
30:00
25:00
20:00
15:00
10:00
5:00
0:00
Peak Period Direction
e/b AM
e/b PM
w/b AM
w/b PM
Slowest Trip
Average
Fastest Trip

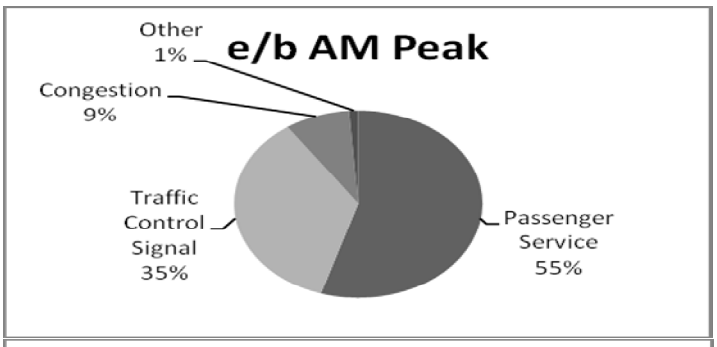
APPENDIX 2

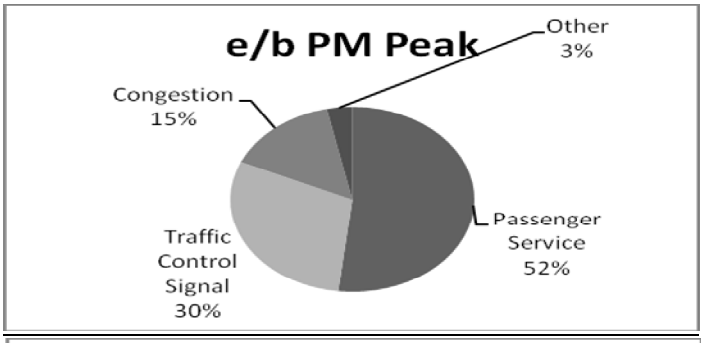


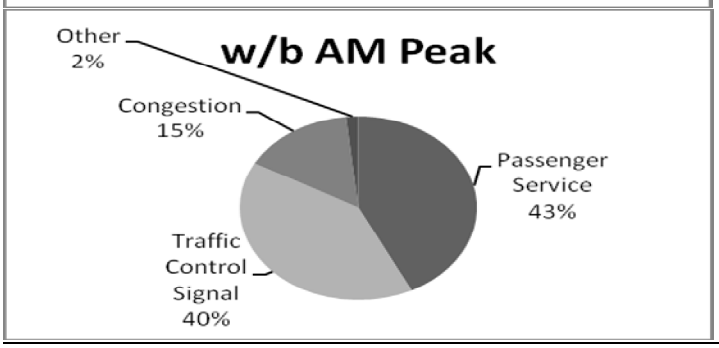
King St. Segment	Length (m)	Travel Time (min:sec)				Travel Speed (km/hr)			
		e/b AM	e/b PM	w/b AM	w/b PM	e/b AM	e/b PM	w/b AM	w/b PM
Jameson to Dufferin (0.7 km)	730	3:03	3:24	3:47	3:30	14.3	12.9	11.6	12.5
RESERVED LANE Dufferin to John (3.2 km)	3,185	13:44	15:34	13:13	17:11	13.9	12.3	14.5	11.1
John to Jarvis (1.5 km)	1,507	8:26	11:06	8:59	10:56	10.7	8.1	10.1	8.3
RESERVED LANE Jarvis to Berkeley (0.6 km)	632	2:05	2:21	2:41	3:18	18.2	16.1	14.1	11.5

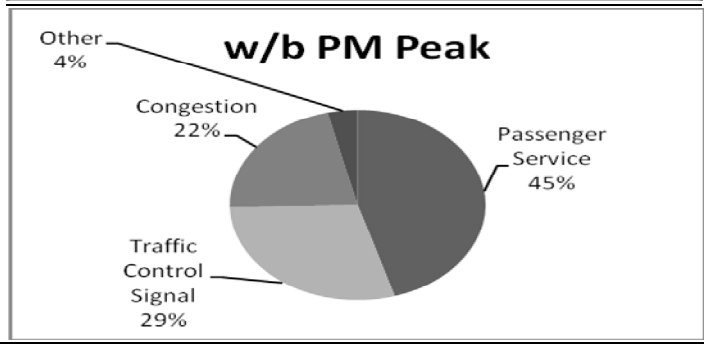
APPENDIX 3


Causes of Delay
by Peak Period Direction
Average Delay per Trip (sec.)
450
400
350
300
250
200
150
100
50
0
e/b AM
e/b PM
w/b AM
w/b PM
Passenger Service Time
Traffic Control Signal
Congestion
Other
Cause

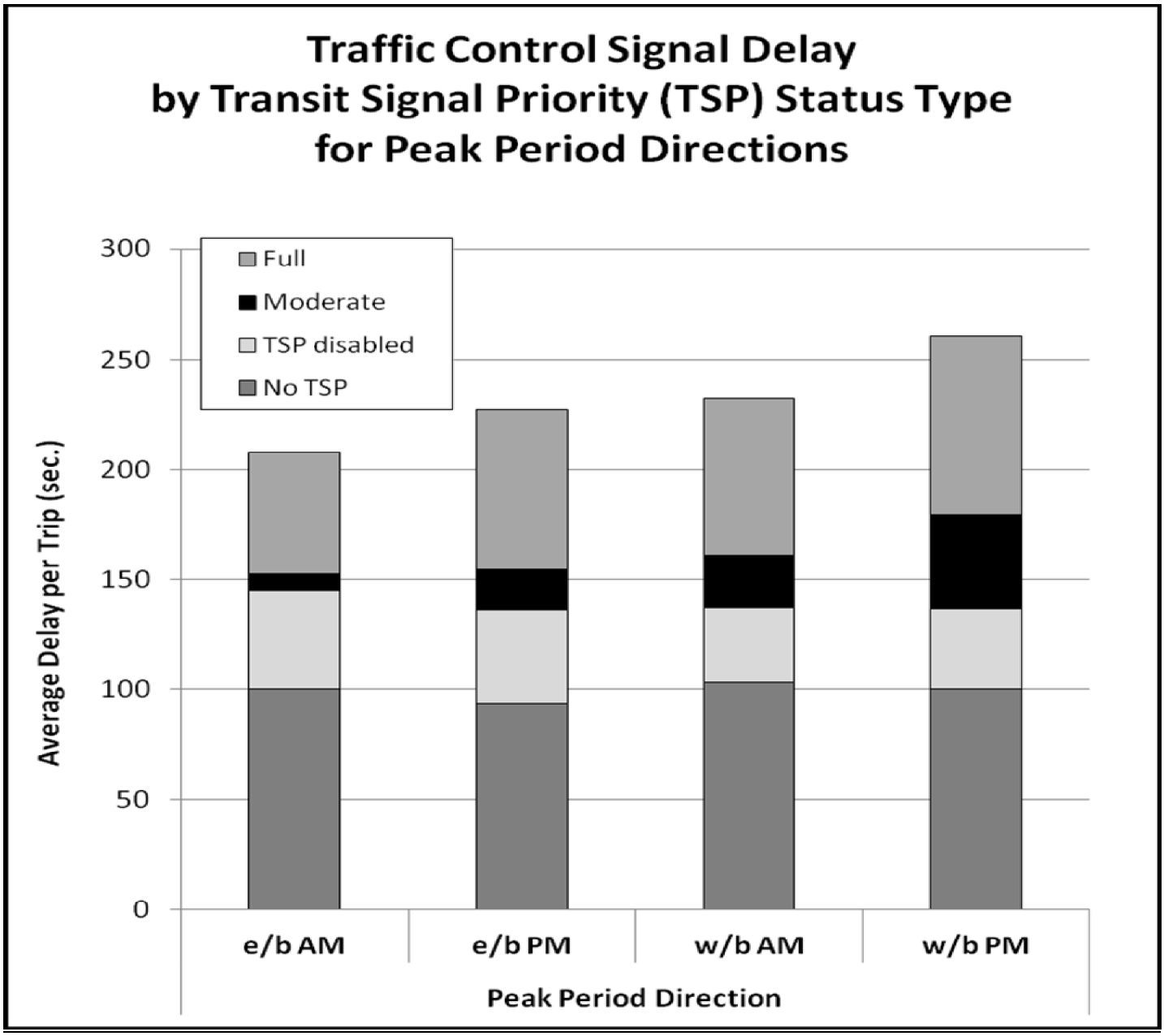

e/b AM Peak
Other 1%
Congestion 9%
Traffic Control Signal 35%
Passenger Service 55%


e/b PM Peak
Other 3%
Congestion 15%
Traffic Control Signal 30%
Passenger Service 52%


w/b AM Peak
Other 2%
Congestion 15%
Traffic Control Signal 40%
Passenger Service 43%


w/b PM Peak
Other 4%
Congestion 22%
Traffic Control Signal 29%
Passenger Service 45%

APPENDIX 4

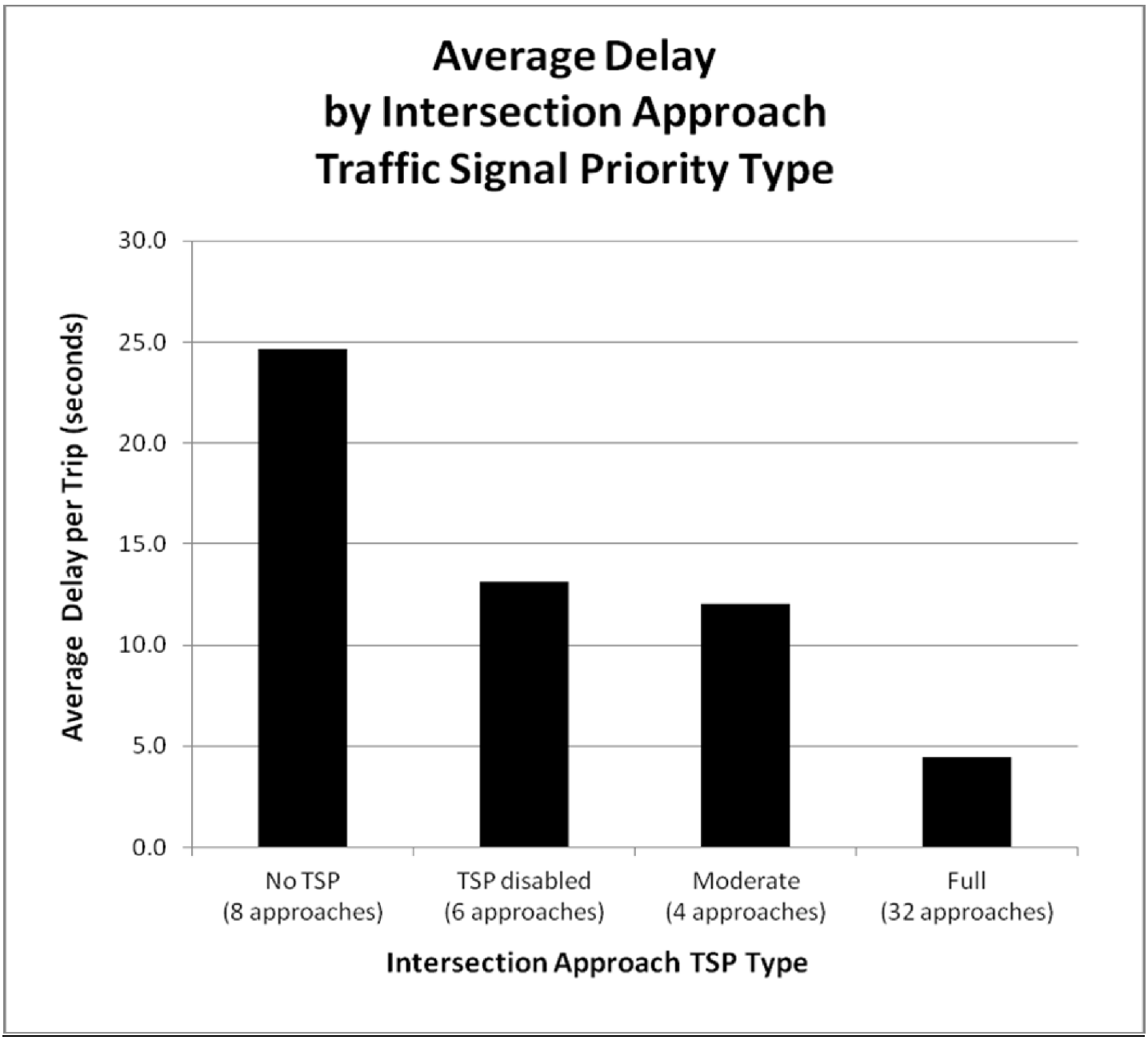


TSP Status	No. of Locations e/b	No. of Locations w/b	Total
No TSP	4	4	8
TSP disabled	3	3	6
Moderate	1	3	4
Full	17	15	32
Total	25	25	50

Notes:

1. **TSP - Transit Signal Priority**
2. **'Full ' and 'Moderate' represents those intersections that are TSP enabled and capable of extending the traffic control 'green' signal 30 and 16 seconds, respectively.**

APPENDIX 5


Average Delay
by Intersection Approach
Traffic Signal Priority Type
Average Delay per Trip (seconds)
30.0
25.0
20.0
15.0
10.0
5.0
0.0
No TSP
(8 approaches)
TSP disabled
(6 approaches)
Moderate
(4 approaches)
Full
(32 approaches)
Intersection Approach TSP Type