Analysing and Mitigating Queues at Signalized Intersections Adjacent to Railway Crossings

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INTRODUCTION & BACKGROUND

- Traffic signal control and railway crossing active warning systems provide the highest degree of control available at intersections and railway crossings, short of grade separation.
- Two issues (shown in Figure 1) may occur due to the close proximity of traffic signals and a railway crossing with an active warning system:
  - Influence Zone (signal to tracks) queue
  - Gate Spill Back (tracks to signal) queue

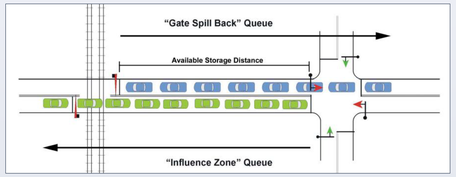

Figure 1. Types of queuing that may occur at railway crossing in close proximity to traffic signals.

- Where a signalized intersection exists in close proximity to a railway crossing, signal pre-emption may be used, which requires coordination between traffic signals and the railway warning system.
- Signal pre-emption serves to ensure that the actions of these separate traffic control devices complement rather than conflict with each other.

CONTEXT FOR STUDY & PURPOSE OF PAPER

- The Region of York identified six signalized intersections that appeared to be regularly extending from the traffic signals past a nearby set of railway tracks.
- According to the Transport Canada *RTD-10* guidelines, signal pre-emption should be considered.
- The Region wished to examine the underlying causal factors that were contributing to the queues at these locations, in order to determine alternative solutions (other than signal pre-emption).
- **The purpose of this project is to present a methodology for analyzing and characterizing queues at signalized intersections in addition to identifying techniques for evaluating the effectiveness of potential mitigating solutions.**

EVALUATING QUEUING POTENTIAL

Review of Video Footage

- Region of York placed a video trailer at the six signalized intersections to record footage of traffic queued at the intersection during the morning (0500 – 1000) and afternoon (1500 – 1900) peak traffic periods.
- Typical view of an intersection shown in Figure 2.

Figure 2. Sample Video Footage

- Associated Engineering (Ont) Ltd. completed an analysis of queuing, gathering information on:
  - The queue lengths at the end of each signal cycle
  - Traffic patterns contributing to the length of queues
  - Time required for a vehicle at the end of a queue to proceed forward
  - Frequency of train crossing the location and associated timing of events leading to and after the passage of the train
  - Potential unsafe driver behaviour associated with the activation of the active warning system
- The results were plotted. Figure 3 provides an example of the morning period where queues regularly extended past the tracks.
- Video analysis provided additional valuable insights into factors that were contributing to the observed queues, which helped AE to diagnose possible solutions.

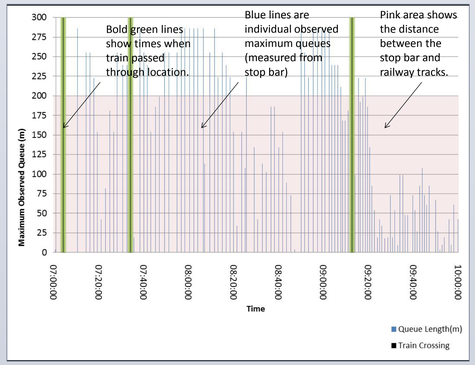

Figure 3. Example of Observed Maximum Queues and Train Crossings (0700 – 1000) at Intersection with Queues Regularly Extending Past Railway Tracks

Queue Modeling with Synchro 7

Analysis done using Synchro 7:

- Operations at the intersections were modelled
- The 95th percentile queue length determined based on signal timing data and turning movement counts provided by the Region
- Estimated the impacts of different mitigation measures on queue length, such as implementing changes to signal timing, modifications to lane storage or the addition of a lane.
- Changes to signal timing or queue detection were not considered to be feasible if existing conditions on the cross street approaches to the same intersection indicated a failing Level of Service (LOS F) and/or extensive queuing

OBSERVATIONS AND IDENTIFIED MITIGATING MEASURES

The observations made based on the video footage in combination with the use of Synchro 7 helped lead AE to diagnose why the queues were occurring and what mitigation measures were considered feasible for mitigating the observed queues.

Changes to Access Management

- Some accesses located just upstream of tracks were causing traffic obstructions at a railway crossing as shown in Figure 4 (showing truck entrance to shopping plaza)
- *Solution:* Turn or time based restrictions to accesses

Figure 4. Truck blocking traffic flow across railway tracks

Changes in Signal Timing

- At locations where the Level of Service on the cross street approach was considered adequate, AE examined the reallocation of green time to the railway crossing approach.
- *Solution:* Adding to the green time on the affected approach resulted in a modest decrease in the 95th percentile queue length in Synchro.
- At one intersection, traffic in the left turn lane was observed queuing back to the tracks while at the same time there were only a few vehicles queued in the adjacent through lane.
- *Solution:* When the length of the protected left turn phase was doubled, the 95th percentile queue length decreased significantly in Synchro.

Adding Turn Lanes

- At two of the signalized intersections, both the turning movement counts and the video footage indicated a heavy right turn movement, although a separate right turn lane was not provided.
- *Solution*: When modeling operations at these intersections with the addition of a right turn lane, there was a substantial decrease in the 95th percentile queue length.

Queue Detection

- Queue detectors, placed further back from the traffic signals and closer to the railway tracks, can be used to detect a queue that is forming with the potential to extend past the railway tracks.
- The use of a queue detector should be considered in the context of the operations on the crossing road approaches and number of times it will be triggered.
- If the likelihood of being queue detection triggered is modest (less than 5 times per hour) or if the crossing road approaches experience excessive queue delays (200+ metres), this method should not be considered.

Changes to Operations at Downstream Intersections

- At two intersections, during peak traffic conditions, traffic from another signalized intersection further downstream was queuing back to the traffic signals at the study intersection.
- Motorists cannot move through the intersection during the green phase, creating queues extending far beyond the railway tracks.
- *Recommendation:* The Region will investigate operations at the downstream intersections and implement an additional through lane and signal timing modifications.

Signal Pre-emption

- The TxtDOT worksheet (prepared by the Texas Department of Transportation in the *Guide for Determining Time Requirements for Traffic Signal Preemption at Highway-Rail Grade Crossings)* was used to determine if additional time is required for the traffic signal to move stationary vehicles out of the railway crossing before the arrival of a train.
- For one intersection, 22 seconds of additional warning time would be required, which is considered feasible.
- In the remaining intersections, 34 – 60 seconds of additional warning time would be required, which is considered to be infeasible at these locations due to:
  - the greater distance between the signals and the railway tracks;
  - the greater uncertainty that the queue would be completely cleared prior to the arrival of the train; and
  - the distance upstream that the advance warning would need to be placed to activate pre-emption at the traffic signals.

Police Enforcement

- Figure 5 shows unsafe behaviour where motorists were observed crossing the tracks while the gates were being lowered.
- *Recommendation:* Police to conduct periodic enforcement at the crossing locations where video footage revealed unsafe motorist behaviour.

Figure 5. Example of unsafe motorist behaviour: Driver crossing railway tracks while gates are being lowered.

CONCLUSIONS

- According to current Canadian standards, road authorities should be investigating the need for signal pre-emption at locations where queues at signalized intersections are regularly extending across an adjacent set of railway tracks, even if the distance between the stop bar at the intersection and the railway tracks exceeds 60m.
- **This project has demonstrated how a road authority can**:
  - investigate and measure queuing extent at signalized intersections using video footage;
  - gain insights into why queues are extending from traffic signals back to a set of railway tracks; and
  - identify potential mitigating measures using Synchro 7.
- The Region of York has been proactive in identifying and characterizing the issue of queues forming at signals that are extending back to a nearby set of railway tracks.
- Many of the solutions identified, such as access management and making adjustment to signal timing, can be implemented in a short time frame and are viable alternatives to signal pre-emption.
- Other treatments, such as adjustments to lane configuration and queue detection, while higher in cost, still offer a solution that are viable alternatives to signal pre-emption.
- Signal pre-emption needs to be considered in the context of:
  - distance between the signals and the railway tracks
  - the greater uncertainty that the queue would be completely cleared prior to the arrival of the train; and
  - the distance upstream (on the railway tracks) that the advance warning would need to be placed to activate pre-emption at the traffic signals.

FURTHER INFORMATION

For further information, please contact Jeff Suggett at suggettj@ae.ca

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