A STRATEGY TO PRESERVE THE ROAD HIERARCHY

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Abstract: *From a trade perspective, the ideal location for a large retail development to establish is alongside a busy road. However, the need to accommodate access to high traffic generating activities from an arterial road often comes at the expense of the efficiency of the frontage road.*

This presentation describes access management assessment techniques that have been developed for Christchurch City Council by Abley Transportation Engineers to balance the needs of providing access to high traffic generating activities against the need to uphold the function of the frontage road.

This presentation will be of interest to transportation engineers that prepare, and road controlling authorities that audit, transport impact assessments for activties desiring access to arterial roads.

INTRODUCTION

There is a need to balance the necessities of traffic access to a land use activity alongside an arterial road against the intended function of the arterial road network. As traffic volumes and trip demands increase on arterial roads so does the delay that is incurred by traffic turning across or onto that arterial road.

Arterial roads usually carry relatively high volumes of traffic. Traffic efficiency is typically the identified key function of an arterial road and less importance is placed on property access. Interruptions generated by vehicle movements from an adjacent site can create inefficiencies along the arterial road and lead to increased crash rates and delays, reduced capacity and deterioration of drivers perceptions of the quality of the road network.

An integrated approach to site planning and road development can potentially regulate interruptions to traffic flow to a degree consistent with the transport functions of the road. This has the benefit of supporting community expectations about the level of safety for the road network. Integrated access management helps to ensure that appropriate and compatible land uses are located next to traffic routes that can provide adequate access without significant detriment to the function of the frontage road.

A number of signalised intersections have been installed in Christchurch over the past 10 years to facilitate vehicle movements from high traffic generating land use developments with frontage to an arterial road. The need to accommodate access to these activities from an arterial road has an effect on the function and efficiency of the arterial road network. The significance and consequences of a sample of six of these signalised intersections has formed the basis of this study.

ASSESSMENT TECHNIQUES

Abley Transportation Engineers developed four assessment techniques to evaluate the effect of a proposed or existing signalised access on the operation of an arterial road. The first of these techniques was developed by referring to Austroads Guide to Traffic Engineering Practice Part 2: Roadway Capacity, the remaining three techniques are new innovative means of evaluating signalised intersection performance against key criteria. The three innovative criteria are presented in this technical note.

Method A - Arterial Road Level of Service

Vehicle delays on the arterial roads for the study sites were typically minimal while delays for vehicles exiting the activity site were generally high, but within acceptable bounds for a signalised intersection.

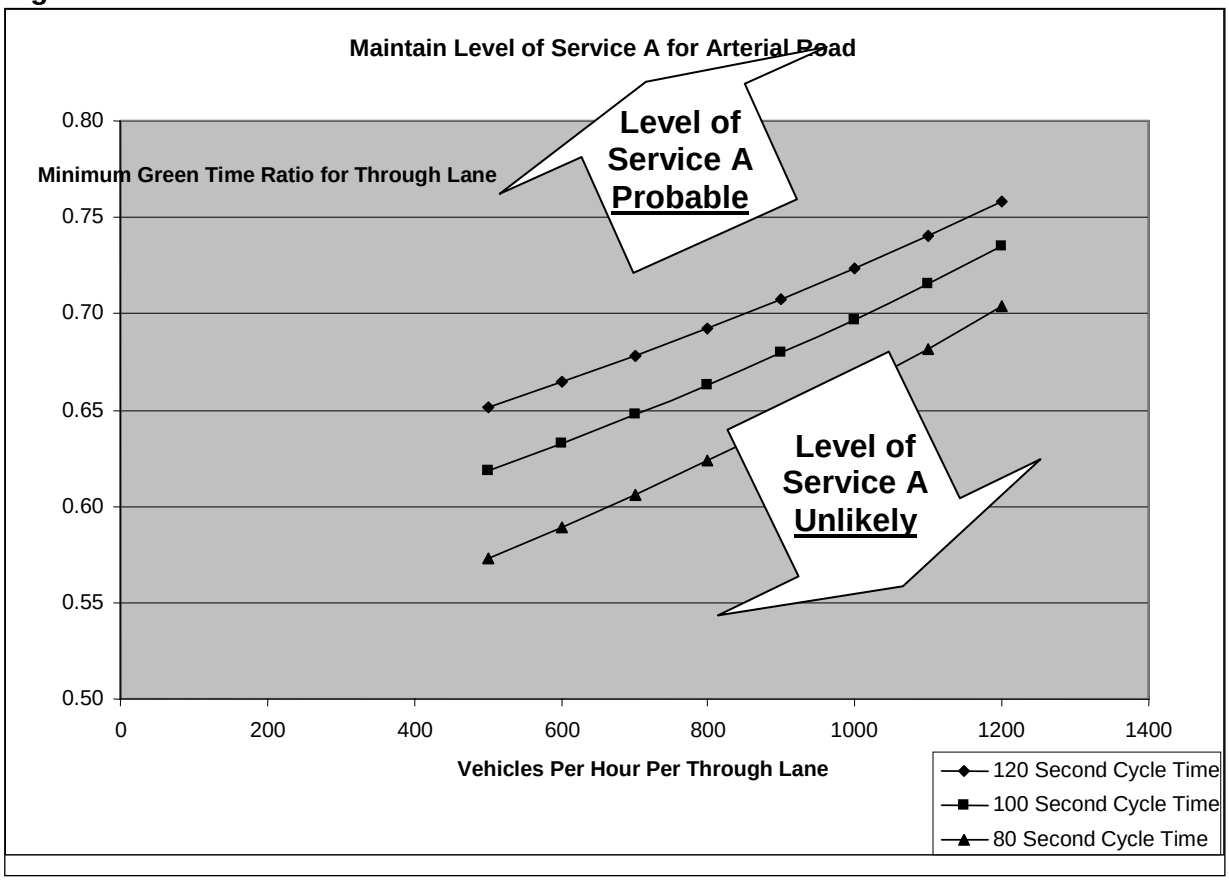
In observing the operation of the intersections that formed the basis of this study, it appears that signalised intersections are unlikely to be significantly detrimental to the function of an arterial road where the Level of Service (based on average control delay) for through movements on the arterial road still operates at Level of Service A. Level of Service A for any movement at a signalised intersection is defined by an average control delay of less than 10 seconds per vehicle. As there is no geometric delay for through vehicles on the arterial road at a signalised intersection, the delay is solely as a result of the slowing, stopping and accelerating cycle encountered by motorists travelling through a signalised intersection.

Abley Transportation Engineers has calculated, from first principles, the approximate minimum green time ratio for through movements on the arterial road given a range of signal cycle times and approach lane traffic flows in order to maintain Level of Service A. These

values are shown in Figure 1 and assume that vehicle arrivals are random and that the through lane is an exclusive through lane i.e. turning vehicles are provided with separate lanes.

Further details on the method for calculating approximate values of delay and other measures of intersection performance are found in Section 9.4 of Austroads Guide to Traffic Engineer Practice Part 2: Roadway Capacity.

Figure 1: Minimum Green Time Ratio to Maintain Level of Service A



The key factor to note with Figure 1 is that as traffic volumes increase on the arterial road a corresponding higher proportion of green time is required in order for the traffic signals not to have a detrimental effect on the operation of the arterial road.

A basic SIDRA Intersection model of an existing or proposed signalised intersection can be developed to determine phase splits required for the arterial road and side road. If the green time ratio afforded to the arterial road exceeds the values shown in Figure 1 above then it is likely that the signals will not have an adverse effect the function of the arterial road. If the green time ratio is below the values shown in Figure 1 above then signalisation of the intersection may be inappropriate.

For proposed signalised intersections, it is possible to determine the maximum volume of traffic that can be generated from the intersecting activity in order for the proposed signalised intersection not to have a detrimental effect on the function of the arterial road.

Method B - Proportion of Queued Vehicles

Another measure to assess the effect of a signalised access on the operation of the arterial road is to measure, or for proposed signals to predict, the proportion of vehicles that would

be delayed by the signals on the arterial road against the number of turning vehicles i.e. those accessing the activity.

The surveys of the six signalised intersections that formed the basis for this study showed that three of the six intersections accommodated more turning vehicles than vehicles that queued at the signals on the arterial road. The results of the survey are graphically illustrated in Figure 2.

Figure 2: Turning Vehicles vs Queued Vehicles

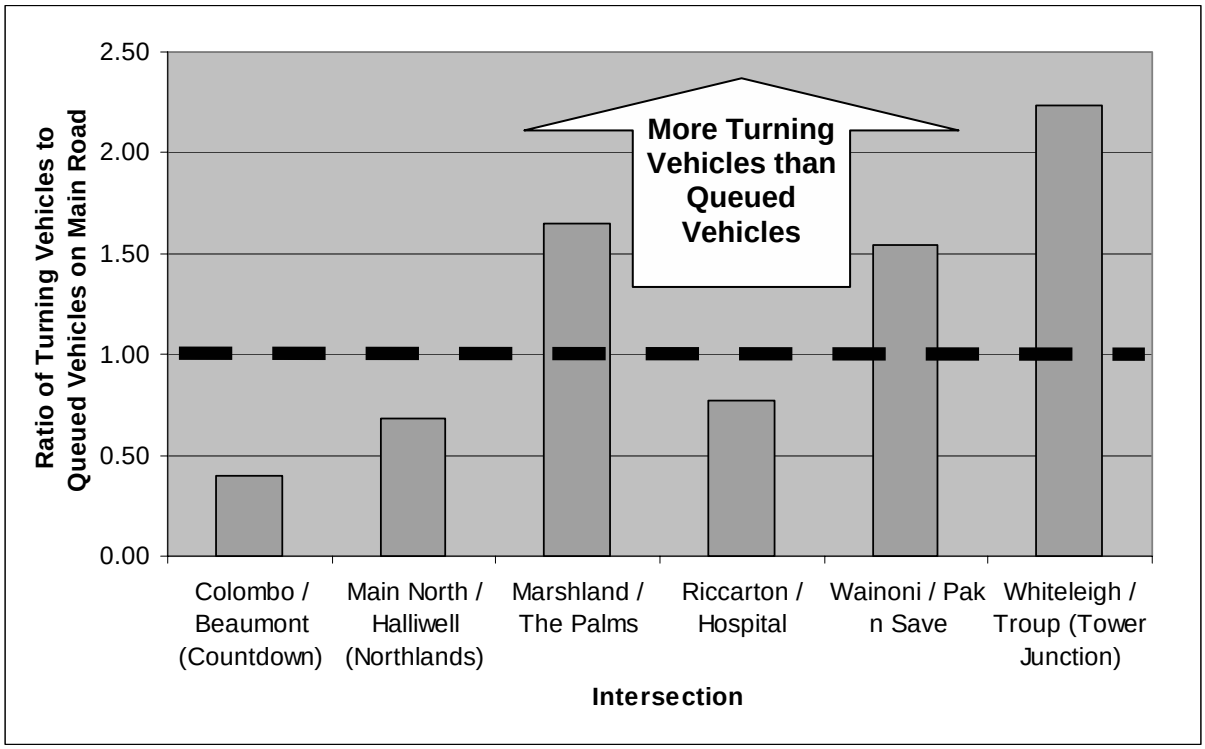


Figure 2 indicates that half of the surveyed intersections delay more vehicles not associated with the adjacent activity on the arterial road than are accessing the activity. In situations where the number of queued vehicles on the arterial road exceeds the number of turning vehicles, this should alert the road controlling authority that signalisation of the access point is prioritising the local access needs of an adjacent activity above the access function of the frontage arterial road.

Method C - Traffic Signal Coordination

In certain circumstances, signalised site access points can be integrated into an existing arterial road without unduly compromising the function of the arterial road. Optimum conditions exist where the traffic movements along the arterial road at the signalised site access can be coordinated with an upstream signalised intersection. The coordination of signalised intersections reduces the likelihood of a through vehicle having to stop at two consecutive intersections.

The highest level of coordination between signalised intersections can be achieved when:

- The intersections operate with the same cycle time;
- There is little separation distance between the two intersections;

- ❖ Where the number of turning vehicles from the adjacent legs of the upstream intersection is low; and

- ❖ Where there are few access points between the two intersections.

In situations where high levels of coordination can be achieved, the number of vehicles that may have to stop on the arterial road can be reduced considerably. This minimises the overall effect of the signalised site access on the function of the arterial road.

The degree of coordination that is possible from an upstream intersection should be assessed as part of the evaluation of a signalised site access proposal. In lieu of a micro-simulation or TRANSYT model that can allow the upstream effects of a signalised intersection to be fully assessed and presented in a visual manner, the following assessment has been developed and tested at a signalised intersection proposal in Christchurch:

1. Prepare a SIDRA Intersection model of the proposed signalised intersection.

2. Set the cycle time of the proposed signalised intersection equal to the cycle time of the upstream intersection from which coordination is possible.

3. Simulate the model and record the amount of green time that the model assigns to movement where coordination is sought.

4. Carry out a site survey to determine the level of coordination that could be achieved at the signalised intersection. To do this:

    (a) Record the number of vehicles that pass through the proposed signalised intersection from the upstream intersection during the time calculated in (3) above. Start recording once the first vehicle(s) that departs the upstream intersection arrive at the proposed signalised intersection.

    (b) Observe and record the number of vehicles that pass through the proposed signalised intersection during the remainder of the cycle time calculated in (2) above.

    (c) Repeat steps (a) and (b) for no less than one hour during the proposed analysis period(s).

    (d) Calculate the level of coordination that could be achieved by dividing the average number of vehicles recorded in Step (a) by the average number of all vehicles recorded in Steps (a) and (b).

5. Modify the level of coordination in the SIDRA Intersection model according to the outcome of Step (4).

6. Report on the difference in the overall level of delay encountered by through vehicles on the arterial road with and without coordination.

At existing intersections, the level of coordination can be determined by comparing the proportion of vehicles that stop on the arterial road at the signalised intersection, against the proportion of vehicles that would theoretically be expected to stop if vehicle arrivals were uniformly distributed.

The proportion of vehicles that stop on any arterial road approach are recorded by site observation. The proportion of vehicles that would stop if vehicle arrivals were uniformly distributed is calculated by determining the proportion of the cycle time that shows a red signal display for each approach. The proportion of vehicles that are observed to stop on any approach will be less than that estimated for uniformly distributed vehicle arrivals if the approach is well coordinated with the upstream intersection. The broad observed relationship from the sample sites is that the 'The higher the level of coordination achieved between signalised intersections the larger the ratio of turning vehicles to queued through vehicles observed at a signalised site access'.

SUMMARY

The study findings from Part 1 of the study suggest that the existing traffic signal installations in Christchurch for activity access points intersecting the arterial road network generally have minimal effects on the function and operation of the arterial road network. However, some of the traffic signal installations may not be the most appropriate form of intersection control given the relatively low volumes of vehicles accessing the signalised activity access point.

These findings and the access management assessment techniques developed by Abley Transportation Engineers are currently under review by Christchurch City Council. This first part of the study is the precursor to an Access Management Strategy for Christchurch to ensure that future proposals to signalise site access points do not detrimentally affect the function and operation of the arterial road network. It is envisaged that this strategy would support the policies and objectives of the City Plan and contain specific target levels of interaction between the road network and adjacent land, as well as stipulating acceptable and unacceptable performance outcomes for access points intersecting the road network. The assessment techniques developed by Abley Transportation Engineers would be an integral part of the strategy to ensure a consistent approach was adopted to assessing existing and proposed signalised intersections. The strategy would also consider other aspects associated with access management including environmental capacity and balancing effects from community and private activities accessing the arterial road network.

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