MELBOURNE AND METROPOLITAN TRAMWAYS BOARD

TRIAL INSTALLATION OF BARRIER KERBING
NICHOLSON STREET - FITZROY

NOVEMBER 1976

1. SUMMARY.

By agreement with the City of Fitzroy concrete barrier kerbs were laid along the eastern side of the tram tracks in Nicholson Street, Fitzroy, between Alexandra Parade and Victoria Parade. These mountable kerbs have provided physical separation between city-bound trams and motor traffic for a twelve month trial period, commencing in October 1975. This report concerns the results of the trial.

A photograph of the barrier kerb and the separated travel modes is shown in Figure 1.

This project aimed to demonstrate the effects of such separation upon both the tram services and the motor traffic. Typical journey conditions for each of these road users were surveyed before and after the installation of the kerbing.

Although there was a reduction in the amount of roadspace provided for motor traffic, there was no increase in delays to cars and in fact both speed and flow rates were improved. The traffic volume has now reached such a level that route capacity has again been reached and delays have risen to their pre-kerb levels. Route capacity appears to have been increased by about 10%.

This improvement in traffic flow is due to the more orderly movement in two continuous lanes rather then in three lanes at mid-block reducing to two lanes at major intersections.

Road safety records show that the introduction of the barrier kerb has not increased the frequency of accidents and may well have reduced it.

Although the degree of interference between motor traffic and city bound trams between intersections was not large prior to installation of the kerbing there was still some reduction in tram journey times. Total journey time reduction was 8%, and the delays between stops, which are those directly affected by the provision of the kerbing, were reduced by about 50%.

Overall, the installation of barrier kerbs in Nicholson Street has demonstrated that such measures can be introduced without disrupting motor traffic. Although the benefit to tram operations was not as great in this case as would be achieved in some others, the project has helped to quantify the improvements in operation that could be anticipated on more congested routes.

2. EFFECTS ON MOTOR TRAFFIC.

Prior to the installation of the barrier kerbing in Nicholson Street southbound motor traffic used three lanes to travel between intersections merging into two lanes beside tram loading zones at major intersections. The third lane between intersections travelled on the city bound tram tracks with frequent interaction betweens trams and cars.

The installation of the barrier kerbing constrained the motor traffic to two continuous lanes throughout. A typical section of the barrier kerb with associated road marking and warning signs is shown in Figure 2.

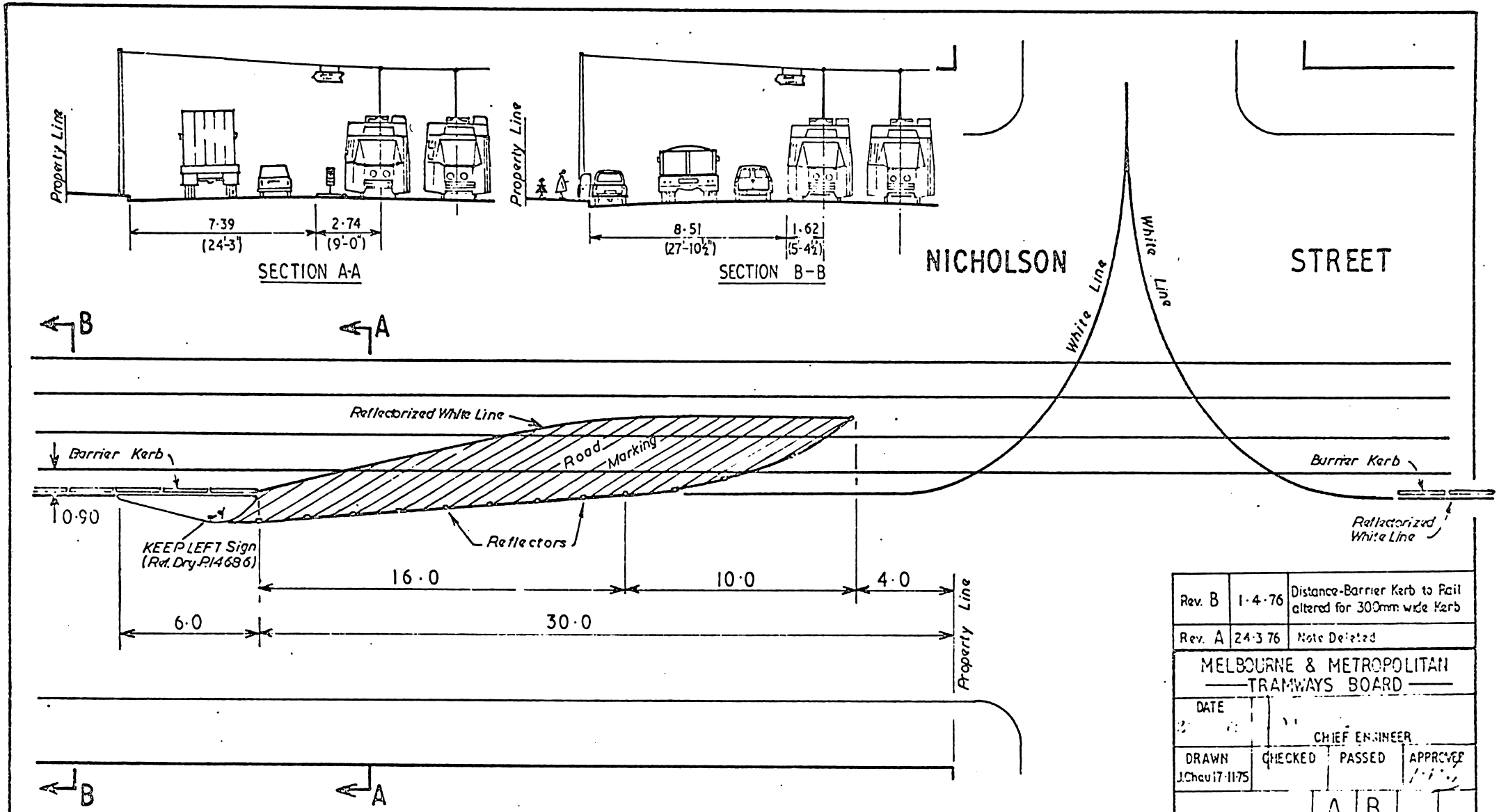
The speed and flow of motor traffic was surveyed regularly during this period and the survey method and results are included in Appendix I. The main features of the results are summarized below.

2.1 Before Installation of Kerbing

A typical average speed between Alexandra Avenue and Victoria Parade during the morning peak period was about 19 km/hour. Of the total time of 5 minutes required to traverse the control section, about 3 minutes was spent in queues at signalized intersections with only 2 minutes actually spent travelling between signalized intersections. The major delay was at Johnston Street.

The rate of flow of traffic was about 1490 tcu's* per hour between Alexandra Parade and Johnston Street reducing to about 1200 tcu's per hour between Johnston Street and Gertrude Street.

* tcu (through car unit) is a means of measuring traffic flow with trucks and turning vehicles considered to be equivalent to a number of through cars.



TYPICAL LAYOUT OF BARRIER KERB, ROAD MARKING & WARNING SIGN

Rev. B	1·4·76	Distance-Barrier Kerb to Fail altered for 300mm wide Kerb
Rev. A	24·3·76	Note Deleted

MELBOURNE & METROPOLITAN TRAMWAYS BOARD

DATE

CHIEF ENGINEER

DRAWN	CHECKED	PASSED	APPROVED
J.Chau 17·11·75			

A B

SCALE. 1:200

P. 14687

Fig. 2

2.2 During Installation of Kerbing

During the week of installation, the traffic was significantly disrupted. On the day of survey, the situation was aggravated by wet weather. Traffic speeds fell by about 30% in both lanes and the increased delays accrued equally in queueing at, and in travelling between, signalized intersections.

The traffic flow rate fell on all parts of the route but more significantly in the north than in the south.

2.3 After Installation of Kerbing

When the installation had been completed, the traffic conditions returned to a state similar to that prior to installation. Average travel speed was again 19 km/hour with similar speeds in each lane. The flow rate of traffic had also recovered and had actually increased in the southern part of the route.

As car drivers became more familiar with the kerbing, the flow of traffic improved further. Traffic speeds averaged as high as 25 km/hr. in some peak periods whilst traffic flow continued to increase.

By the end of the trial period the volume of motor traffic in Nicholson Street had increased by about 10%. However, the capacity of the intersections, particularly at Victoria Parade, became insufficient to meet this demand and traffic delays increased again to a level similar to that prior to the installation of the kerb.

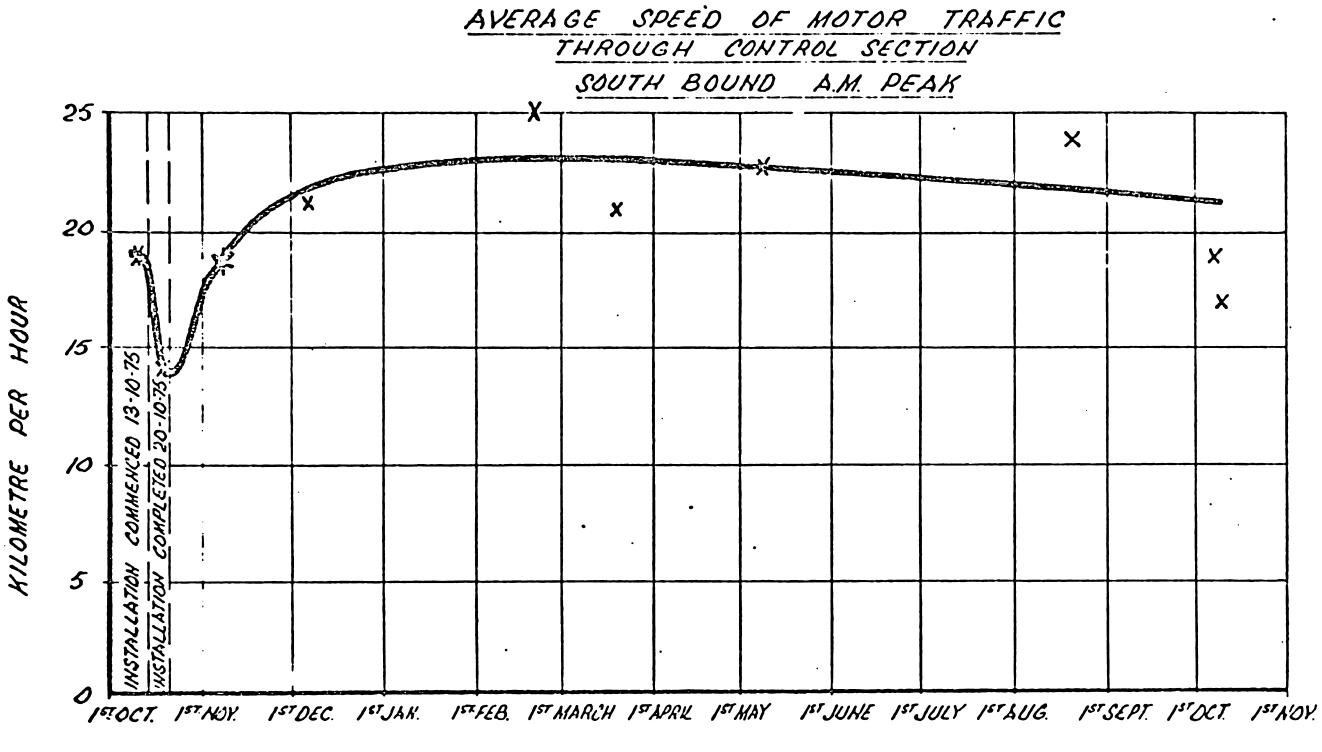
2.4 Conclusions

The installation of barrier kerbing in Nicholson Street improved the flow of motor traffic. This improvement initially took the form of reduced travel times then, as traffic demand increased, carried that increased traffic without increasing delays.

The changing conditions of flow are shown in Figure 3.

Changes in journey times resulted from changes in the lengths of queues at traffic signals and not from changes in time spent travelling between intersections. The more orderly approach to intersections, with two continuous lanes rather than three lanes merging into two, resulted in improved flow.

TRIAL INSTALLATION OF BARRIER KERBS
NICHOLSON ST. – FITZROY
ALEXANDRA PARADE TO VICTORIA PARADE
1975 - 6



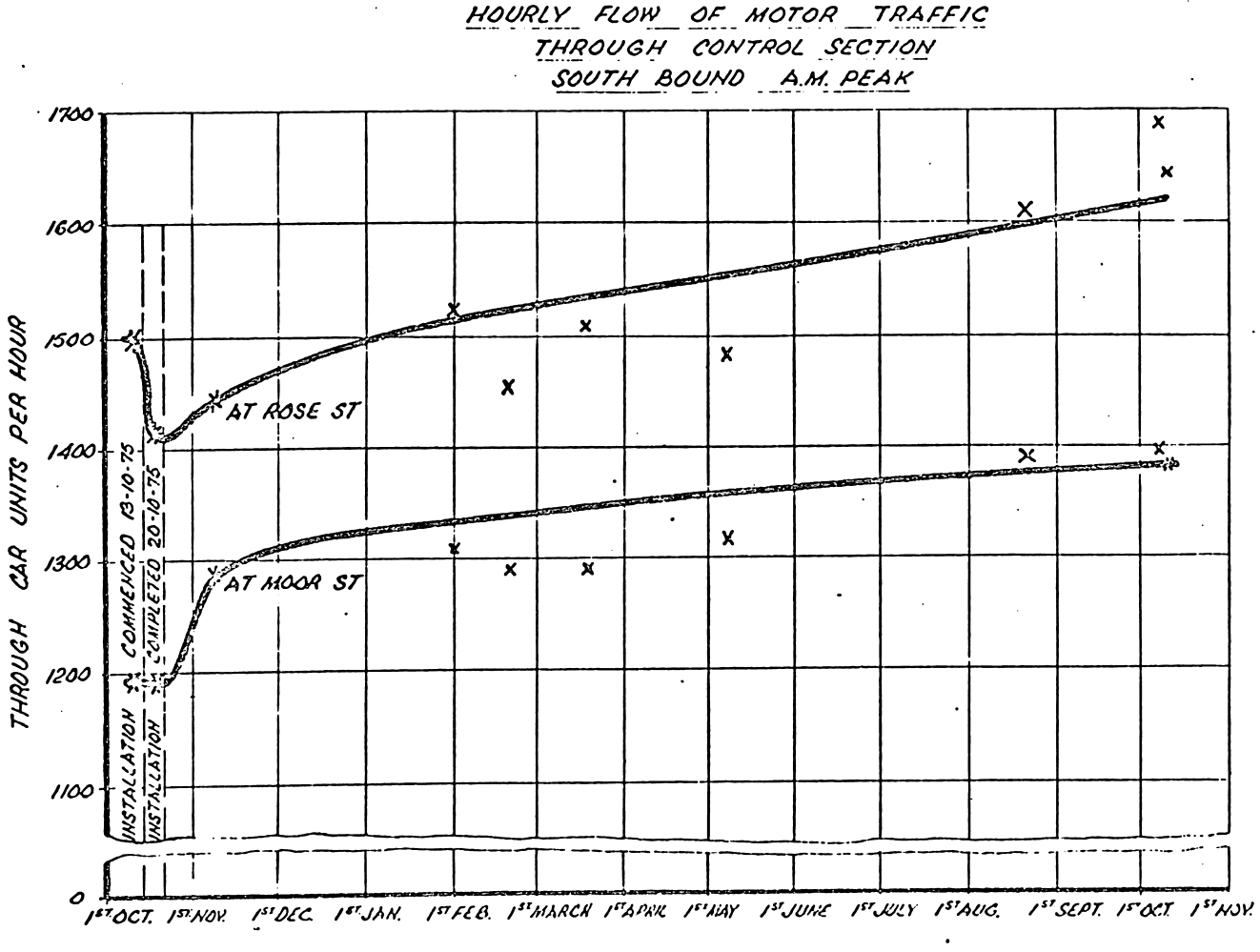


Fig. 3

3. EFFECTS ON TRAM SERVICES.

3.1 Introduction -

The installation of barrier kerbing prevents motor traffic from driving and queuing on the tram tracks on the eastern side of Nicholson Street. This obviously affects city-bound (up) tram services and may also affect out-bound (down) trams in not being hindered by the opposing traffic flow.

For the city-bound tram services, safety zones were already provided at major stops and improvements to tram operations could mostly be expected to arise from a reduction in delays between stops. These delays have never been great and therefore the improvement in tram operations would not be expected to be as great as along some other routes.

Improvements to tram operations can take two forms. Firstly, the overall running time may be reduced with benefits both to tram passengers and to tram operations. Secondly, the regularity of the service may be improved so that average passenger waiting times are reduced and tram loadings are more even. Both these factors have been measured in surveys completed before and after the kerb was installed.

3.2 The Method of Analysis -

The total tram running time through the study section between Alexandra Parade and Victoria Street consists of a base running time plus a series of delays. The base time is the time required to travel the length of the section at cruising speed without stops except at beginning and end. Additional time is required at stops to pick up and to put down passengers (loading time) with further time spent waiting for traffic signals to change (signal delays), for right hand turn vehicles to clear the tracks (traffic delays) and for other miscellaneous reasons such as pedestrian crossings, and bundy clocks. Additional time is required between stops for acceleration and deceleration and for delays arising from general inter-stop interference.

On-vehicle observers on runs along Nicholson Street measured each of these time components on days before and after barrier kerb installation. These surveys aimed to determine what the main sources of delay were and what effect the barrier kerb had on reducing these delays. Trips in both directions in each peak were surveyed with an average sample size of 10 runs in each case.

3.3 Results -

The information provided by the surveys is presented in Tables 1, 2, 3 and 4. In each table the total journey time is expressed as the sum of the components as discussed in the preceeding section.

The total journey time ranged from a minimum average of 278 seconds for outbound trams in the A.M. peak to 526 seconds for out-bound trams in the P.M. peak. This is a range of 1.8 to 3.4 times the base running time.

Most of the excess of journey time over base running time arises from time spent at stops and this is independant of the provision of barrier kerbing between stops. However, delays also arise between stops due to many causes, some of which are -

(i) cars driving on tracks,

(ii) cars queuing on tracks,

(iii) cars turning across tracks,

(iv) tram driver adopting less than optional operating speeds,

(v) tram performance not up to standard.

In most cases, prior to installation of kerbing, these inter-stop delays totalled about 15% of total journey time though for outbound trams in the P.M. peak the figure was higher than 25% (128 seconds).

After installation of the kerbing the inter-stop delays to city-bound trams were halved from 50 seconds to 25 seconds. Though

there was considerable variability in most aspects of tram journey times, it appears that this was a real and consistant improvement in tram service. The 25 second saving provides about an 8% reduction in journey time through the section. The 8% reduction may not be large in absolute terms over this short section of route but would total several minutes over a longer section.

The remaining 25 seconds of inter-stop delays appears to be due to tram drivers not taking full advantage of the clear running conditions provided by the kerbing.

The installation of kerbing on the western side of Nicholson Street could be expected to reduce inter-stop delays in the P.M. peak from about 120 seconds to 25 seconds. This would reduce journey times by about 20%.

3.4 Conclusion -

Although the degree of interference between motor traffic and city-bound tram services was not great prior to installation of the barrier kerb, there was still a significant reduction in tram journey times. The possibilities for improving journey times for outbound trams by installing barrier kerbs on the western side of Nicholson Street are even greater.

	Before Kerbing		After Kerbing	
Time Spent at Stops				
- Loading	67		67	
- Signals	81		57	
- Traffic	1		1	
- Other	1		0	
Total		150		125
Time Spent between Stops				
- Base time	156		156	
- Accel./Decel.	58		60	
- Other delays	52		25	
Total		266		241
TOTAL JOURNEY TIME		416		366

TABLE 1 - Journey Times for City-bound Trams in the AM Peak.

	Before Kerbing		After Kerbing	
Time Spent at Stops				
- Loading	13		20	
- Signals	37		39	
- Traffic	10		22	
- Other	1		1	
Total		61		82
Time Spent between Stops				
- Base time	156		156	
- Accel./Decel.	36		37	
- Other delays	25		33	
Total		217		226
TOTAL JOURNEY TIME		278		308

TABLE 2 - Journey Time for Out-bound Trams in the AM Peak.

	Before Kerbing		After Kerbing	
Time Spent at Stops				
- Loading	29		49	
- Signals	44		32	
- Traffic	9		6	
- Other	12		16	
Total		94		103
Time Spent between Stops				
- Base time	156		156	
- Accel./Decel.	49		45	
- Other delays	49		27	
Total		254		228
TOTAL JOURNEY TIME		348		331

TABLE 3 - Journey Times for City-bound Trams in the PM Peak.

	Before Kerbing		After Kerbing	
Time Spent at Stops				
- Loading	41		58	
- Signals	49		42	
- Traffic	47		97	
- Other	3		10	
Total		140		207
Time Spent between Stops				
- Base time	156		156	
- Accel./Decel.	57		56	
- Other delays	128		107	
Total		341		319
TOTAL JOURNEY TIME		481		526

TABLE 4 - Journey Times for Out-bound Trams in the PM Peak.

4. EFFECTS ON ROAD SAFETY.

The introduction of a physical divider in the centre of the road, such as the barrier kerb, has effects on all road users. These include pedestrians, trams and emergency vehicles as well as the general motor traffic.

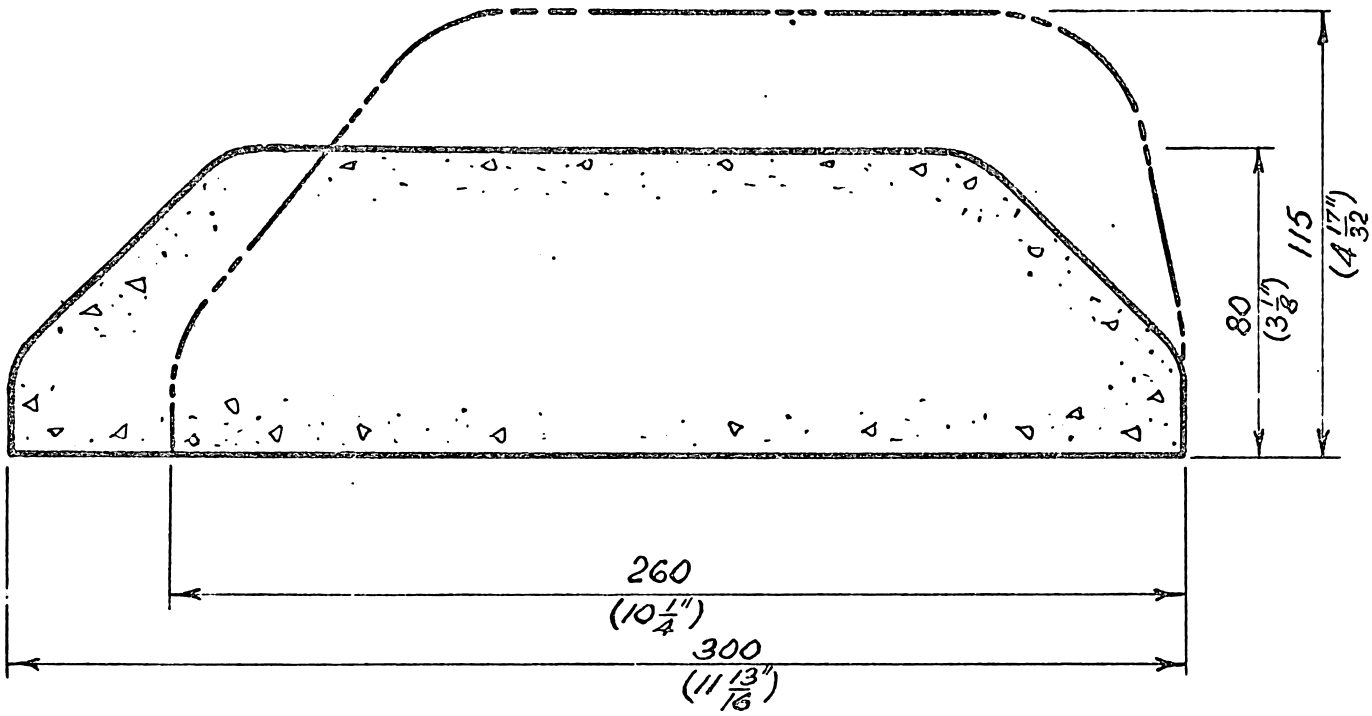
Pedestrian safety appears to have been improved by the introduction of the barrier kerb. When crossing Nicholson Street pedestrians no longer need to traverse six lanes of traffic but can cross two lanes and then take refuge on the tram tracks, taking due care to beware of trams. They can then tackle the remaining lanes of traffic.

Tram drivers obviously benefit from having a clear run without the danger of cars suddenly pulling into their path. The reduced stress on tram drivers should not be underestimated.

The kerb also establishes a traffic-free lane for emergency vehicles. The kerb was initially 115 millimetres ($4\frac{1}{2}$ inches) high and posed some difficulties for such vehicles to cross it to enter and leave the tram lane. A new kerb only 80 millimetres (3 inches) high was then introduced after tests witnessed by Council, Ambulance, Fire Brigade and Police representatives. It is fully mountable with more gently sloping faces.

The two kerb profiles are shown in Figure 4.

TRAMS ← MOTOR TRAFFIC →



Notes :-

New type of kerbing now installed shown ——————

Original type of kerbing shown — — — —

PRECAST REINFORCED CONCRETE BARRIER KERBING

MELBOURNE & METROPOLITAN TRAMWAYS BOARD			
DATE 4-6-76	CHIEF ENGINEER		
DRAWN R.J.H. 4-6-76	CHECKED	PASSED	APPROVED D&L
SCALE 1:2	P.14717		

Fig. 4

The accident history of this section of Nicholson Street has been examined using information provided by the Road Safety and Traffic Authority. It contains all accidents reported to the Victoria Police until the end of June 1976. This provides an $8\frac{1}{2}$ month survey period after the kerb was installed and this is compared with a similar period prior to installation. The results are presented below.

	Accidents at Intersections		Mid-Block Accidents		Total	
	Before	After	Before	After	Before	After
Southbound Traffic	6	6	7	3	13	9
Northbound Traffic	8	8	1	3	9	11
Total	14	14	8	6	22	20

TABLE 5. ACCIDENT HISTORY OF THE TRIAL SECTION OF NICHOLSON STREET.

Although the survey period is not extensive enough to draw firm conclusions from these results, it does appear that the kerb has not detrimentally affected car safety. The most relevant factor is the number of mid-block accidents for southbound traffic and these accidents appear to have decreased in frequency.

Overall, for all road users, the kerb does not appear to have adversely affected road safety.

APPENDIX I - THE TRAFFIC SURVEY.

(a) Measuring traffic flow rate -

The A.M. peak period city bound traffic flow rate was measured regularly throughout the trial period. The counts were performed by Board employees.

The numbers of vehicles in Nicholson Street passing the point just south of Rose Street and the point just south of Moor Street were noted in each 15 minute period between 7.30 and 9.00 a.m. Commercial vehicles, defined as vehicles larger than a panel van, were noted separately and assumed to be equivalent to two standard vehicles.

Flow rates were calculated both in terms of hourly flow rates in the peak half-hour and in the peak hour.

(b) Measuring traffic speed -

The time taken to drive from the southern building line at Alexandra Parade to the northern building line at Victoria Parade was recorded regularly under A.M. peak period conditions.

Two sedan motor cars, each manned by a driver and observer, were driven as "floating" vehicles, at the general traffic speed. By driving predominantly within one lane but overtaking obstructing vehicles where safe to do so, the behaviour of typical motorists was simulated. The average traffic speed was monitored by

passing approximately the same number of vehicles as overtook the floating vehicles.

At least nine test runs were made on most days. The U.S. National Committee on Urban Transportation procedure manual on "Determining Travel Time" considers this to be an adequate number for sampling traffic speeds.

Test results are tabulated below.