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An Investigation of the Performance of Roundabouts with Metering Signals

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Roundabouts with Metering Signals

A major project was undertaken for **VicRoads**, the state transport authority in Victoria, to investigate the performance of **roundabouts with metering signals** in Melbourne, Australia.

The project included comprehensive **surveys of traffic and driver behaviour** at roundabouts with metering signals.

The research objectives included **further development of analytical techniques** to assess the performance of roundabouts with metering signals, and calibration and validation of these techniques for incorporation into the **SIDRA INTERSECTION** software.

Roundabouts with Metering Signals

Unbalanced flows at roundabouts

There are many examples of roundabouts with **unbalanced flow patterns** in Australia, where **part-time** roundabout metering signals are used to **create gaps in the circulating stream** in order to solve the problem of **excessive queuing and delays** at approaches affected by highly directional flows.

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Metering Signals

The use of metering signals is a cost-effective measure to avoid the need for a **fully-signalized intersection** treatment.

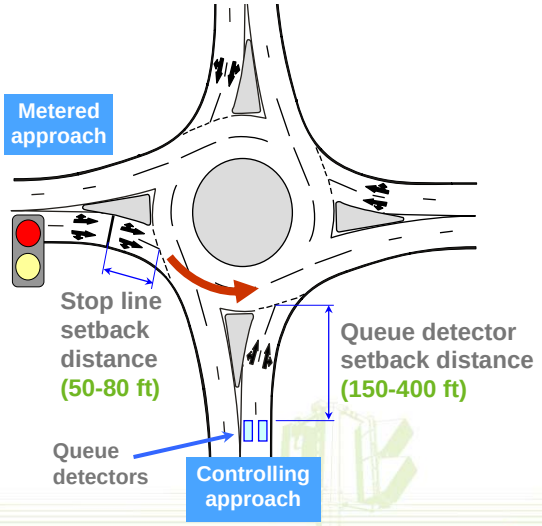
Roundabout metering signals are often installed on selected approaches and used on a **part-time** basis since they are required only during **peak demand periods**.

The Australian (**AUSTROADS**) roundabout and traffic signal guides acknowledge the problem and discuss the use of metering signals.

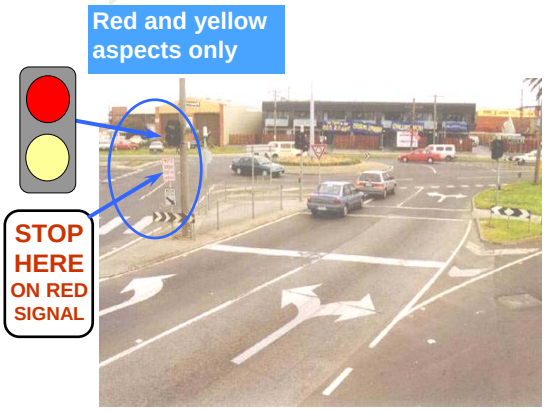
Typical arrangements for roundabout metering signals

Metered approach: the approach stopped by red signals (approach **causing problems** for a downstream approach).

Controlling approach: the approach with the **queue detector** (approach **helped by metering signals**).



Operation of metering signals

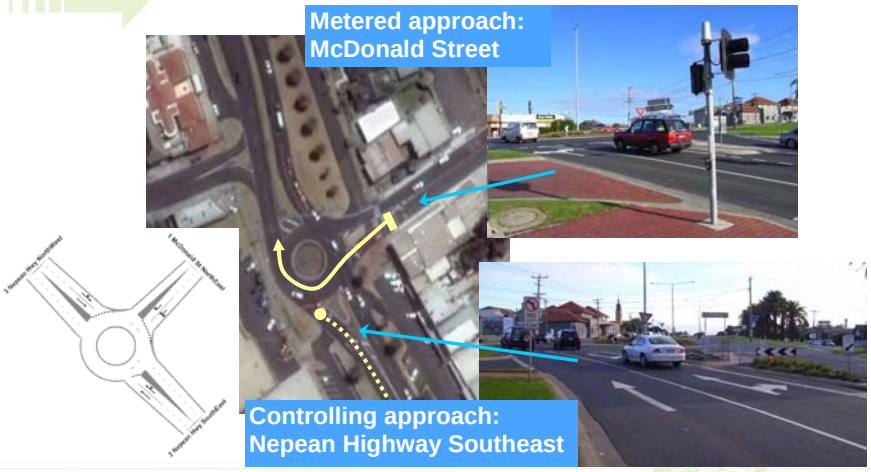


When the queue on the controlling approach extends back to the queue detector, the metered approach signals display red so as to create a gap in the circulating flow.

When the red display is terminated on the metered approach (blank display), the roundabout reverts to normal operation.

Metering signals: Nepean Hwy - McDonald St

(a case study published previously in this paper)



Surveys

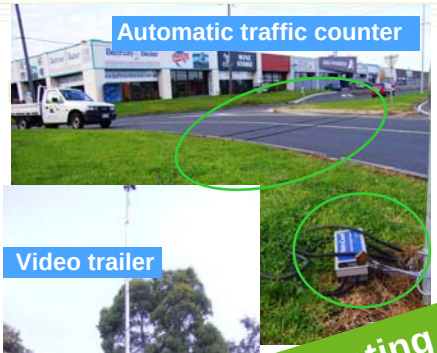
Twenty roundabouts with metering signals were considered as candidates for the project. Following site visits, **five multi-lane roundabout sites** were chosen for surveys (1 to 3 circulating lanes).

The peak 15-min intersection volumes at these sites were in the range approximately **3300 to 6000 veh/h**.

Survey Data

- Video recordings of driver gap acceptance behaviour
- Turning movement volume counts
- Automated counting of circulating traffic
- GPS-equipped floating car surveys
- Metering signal timings

Roundabouts with Metering Signals

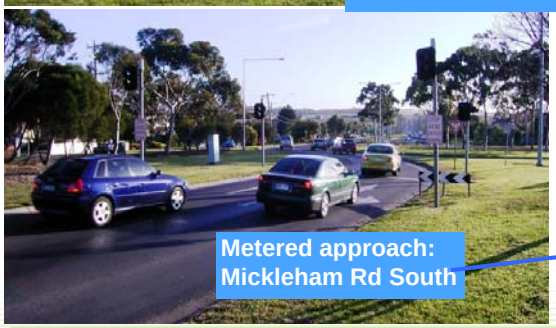


+ Floating cars with GPS units

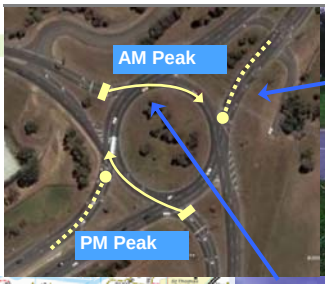
Roundabouts with Metering Signals

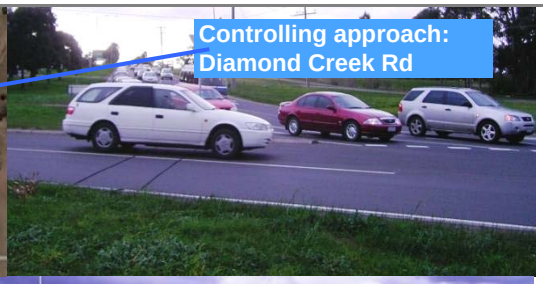
Mickleham Rd / Broadmeadows Rd, AM Peak

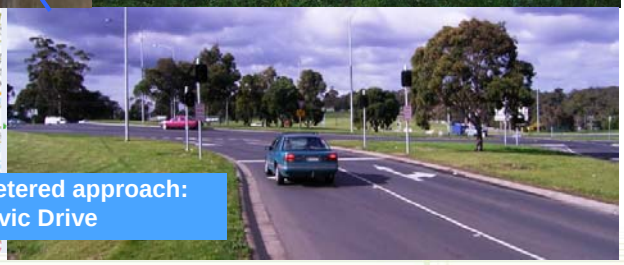
Controlling approach: Mickleham Rd North



Greensborough Bypass / Diamond Creek Rd, AM Peak

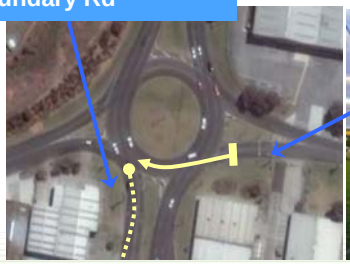






Roundabouts with Metering Signals

Boundary Road / Governor Road, PM Peak



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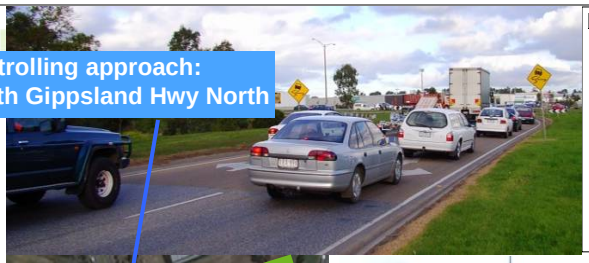
South Gippsland Hwy / Pound Rd, PM Peak



Roundabouts with Metering Signals

Video Presentation

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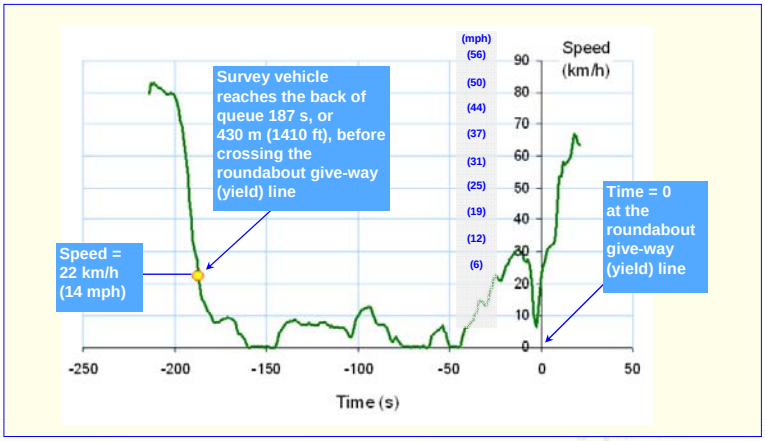
Characteristics of entering traffic:
Queue length and delay from GPS data



Characteristics of entering traffic:
Queue Length and Delay

Site	Approach	Number of Runs	Average Queue Length (ft)	Average Time in Queue (s)
Mickleham Rd - Broadmeadows Rd Deviation	Controlling	27	75	6
	Metered	28	23	2
Greensborough Bypass - Diamond Creek Rd (Morning)	Controlling	31	331	37
	Metered	30	135	40
Greensborough Bypass - Diamond Creek Rd (Afternoon)	Controlling	21	328	29
	Metered	29	312	103
Boundary Rd - Governor Rd	Controlling	25	1201	119
	Metered	23	469	72
South Gippsland Hwy - Pound Rd	Controlling	15	2031	181
	Metered	14	1050	377

Characteristics of entering traffic: Measured and estimated (SIDRA INTERSECTION) critical gap and follow-up headway values

	Circulating Traffic		Entry Lane Traffic		Measured		Estimated	
	Flow Rate (veh/h)	HVs	Flow Rate (veh/h)	HVs	Critical Gap (s)	Follow-up Headway (s)	Critical Gap (s)	Follow-up Headway (s)
Metered and controlling approaches together								
Minimum	134	0.0%	174	0.0%	2.13	1.44	2.17	1.43
15th percentile	356	1.1%	288	0.7%	2.79	2.02	2.54	1.84
Mean	674	4.6%	677	3.4%	3.20	2.30	3.37	2.10
85th percentile	984	8.6%	985	6.7%	3.60	2.59	3.98	2.38
Maximum	1365	14.5%	1130	12.5%	4.31	3.25	4.83	3.11

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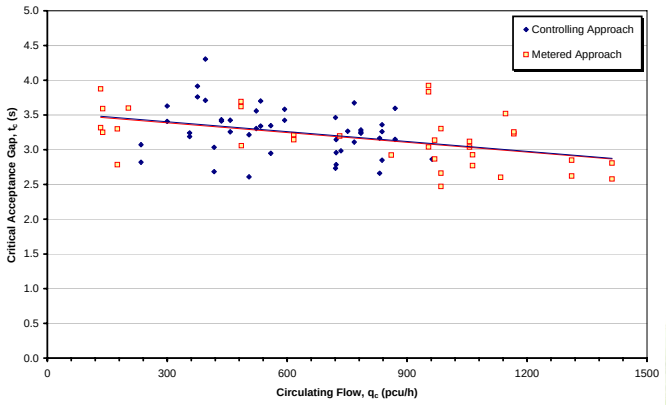
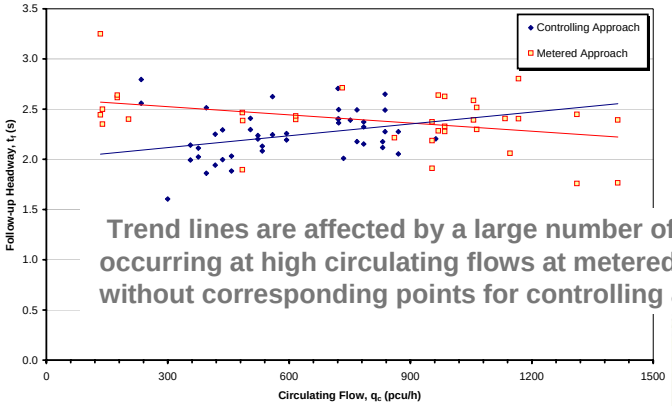
Characteristics of entering traffic: Measured critical gap values for controlling and metered approaches



Characteristics of entering traffic: Measured follow-up headway values for controlling and metered approaches



Trend lines are affected by a large number of points occurring at high circulating flows at metered approaches without corresponding points for controlling approaches.

Other findings

- The critical gap and follow-up headway values measured at the survey sites showed negligible difference in these entry traffic gap-acceptance parameters between dominant and subdominant lanes. This finding differs from the earlier research findings of Troutbeck based on data collected on Australian roundabouts more than 20 years ago.

Roundabouts with Metering Signals

- Survey data indicated **lower proportion of bunched vehicles** for circulating traffic compared with the models based on data reported by Troutbeck (different methods used). Based on the survey data, it did not appear to be possible to attribute the higher levels of proportion free at the survey sites to the effect of metering signals.

Roundabouts with Metering Signals

- Comparisons of measured **delay and queue values** with those estimated by the SIDRA INTERSECTION confirmed an important issue to be taken into account in the design of roundabouts. **Demand volumes** at oversaturated approaches will be underestimated as a result of the use of **turning movement volumes counted at the give-way (yield) lines** rather than demand volumes measured beyond the back of queues. This will result in **underestimation** of benefits from roundabout metering signals and other intersection improvements, and may result in inadequate design.

Roundabouts with Metering Signals

- Survey data collected during this project indicated that the average queue spacing on approach roads is about **10 m (33 ft) per vehicle** (for light vehicles). This is larger than the average queue spacing observed at signalised intersections (for light vehicles, SIDRA INTERSECTION uses a default value of **7 m (23 ft)** for the standard left-hand version, and 7.6 m (25 ft) for the US version.
- This is due to the continual flow discharge from the front of the **moving queue**.

Roundabouts with Metering Signals

- **Further research** is recommended to establish whether these findings are specific to relatively large roundabouts with metering signals, or to all roundabouts generally (e.g. because driver behaviour may have changed after increased familiarity with roundabouts and increased saturation levels at roundabouts).
- Surveys of smaller single-lane and multi-lane roundabouts that carry moderate demand volumes with no metering signals should be undertaken for this purpose.

End of Presentation