Trial of high speed, high traffic volume road marking treatments to encourage improved overtaking distances

Final Report

150 YEARS IN AOTEAROA

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This report ('Report') has been prepared by WSP exclusively for Waka Kotahi (NZ Transport Agency) ('Client') in relation to cyclist and vehicle lane position monitoring on State Highway 2 in Wellington ('Purpose') and in accordance with the Short Form Agreement with the Client dated 2nd November 2020.

The findings in this Report are based on and are subject to the assumptions specified in the Report and the Offer of Service dated 5th October 2020.

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Document History and Status

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Revision	Details
1	Draft report for client
2	Draft report for client
3	Final report for client

Revision Details

Revision	Date	Author	Reviewed by	Approved by	Status
1	28/06/2021	s 9(2)(a)			Draft
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Project background

- State Highway 2 is the only direct travel route for cyclists between Lower Hutt and Wellington and while a large part of the south bound section of this route is on a dedicated, separated, cycle path, all north bound riding, and part of the south bound, is on the shoulder.

- For the sections of the route where the cyclists are required to ride along the shoulder Waka Kotahi has implemented several treatments to indicate where cyclists should ideally position themselves and to alert vehicle drivers to the potential location of cyclists in the shoulder.

- Waka Kotahi wished to understand how cyclists, and vehicles passing cyclists, are positioning themselves in the carriageway where these various treatments have been applied compared to where there are no such treatments to evaluate their effectiveness and wider application.

Project methodology

- Using lidar/radar devices, data was captured from six static (three mitigation and three control) locations along SH2 between Ngauranga and Kennedy Good Bridge in Belmont.

- These locations were picked to cover various cycling conditions (discussed later)

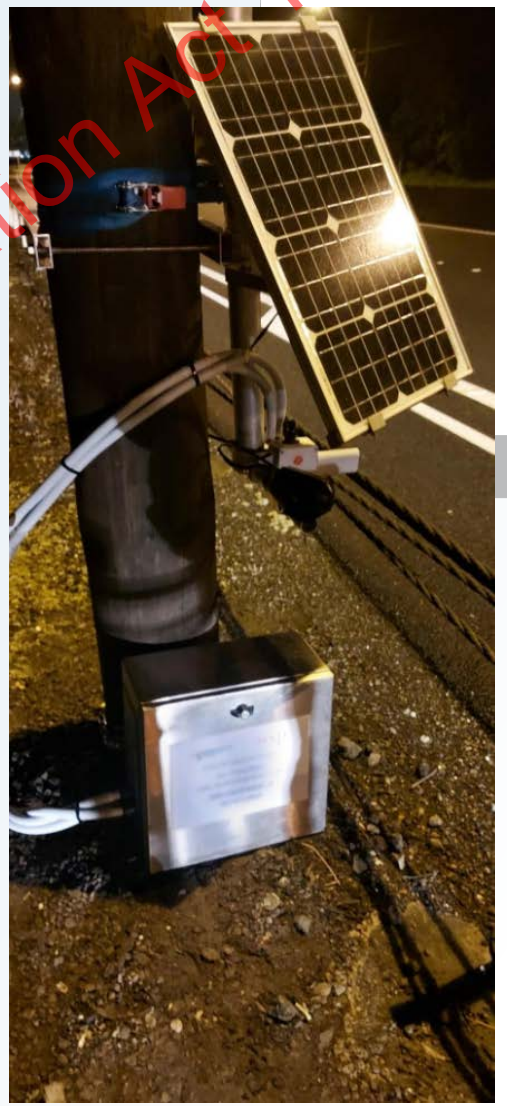
- A week's worth (covering week day and weekend cycling) of data was collected at each location with the mitigation locations being compared against corresponding control locations for statistical differences in passing distance and speed between motor vehicles and cyclists.

- Data was collected between the 6th of April 2021 and the 3rd of June 2021

Monitoring equipment

The equipment (pictured to the right) for this study used a mixture of Lidar and Radar to collect the following information:

- Cyclist position
- Vehicle position (closest lane)
- Vehicle speed (closest lane)



Data collection sites

Mitigation sites

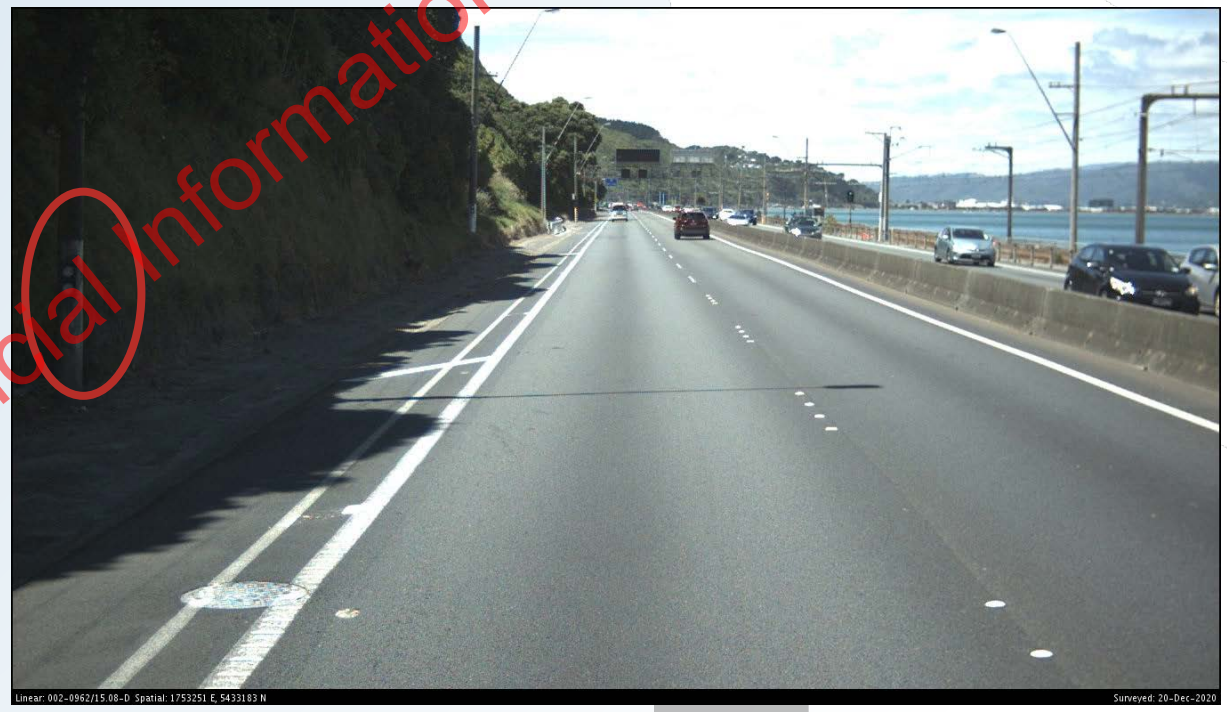
- Buffer on straight
  - Buffered cycle zone on a straight section of carriageway
- Buffer on curve
  - Buffered cycle zone on a curved section of carriageway
- Green blocks
  - Green block cycle zone on a straight section of carriageway

Control sites

- No buffer on straight
  - Control cycle zone on a straight section of carriageway
- No buffer on straight
  - Control cycle zone on a curved section of carriageway
- No green blocks
  - Control cycle zone on a straight section of carriageway

Buffer on straight

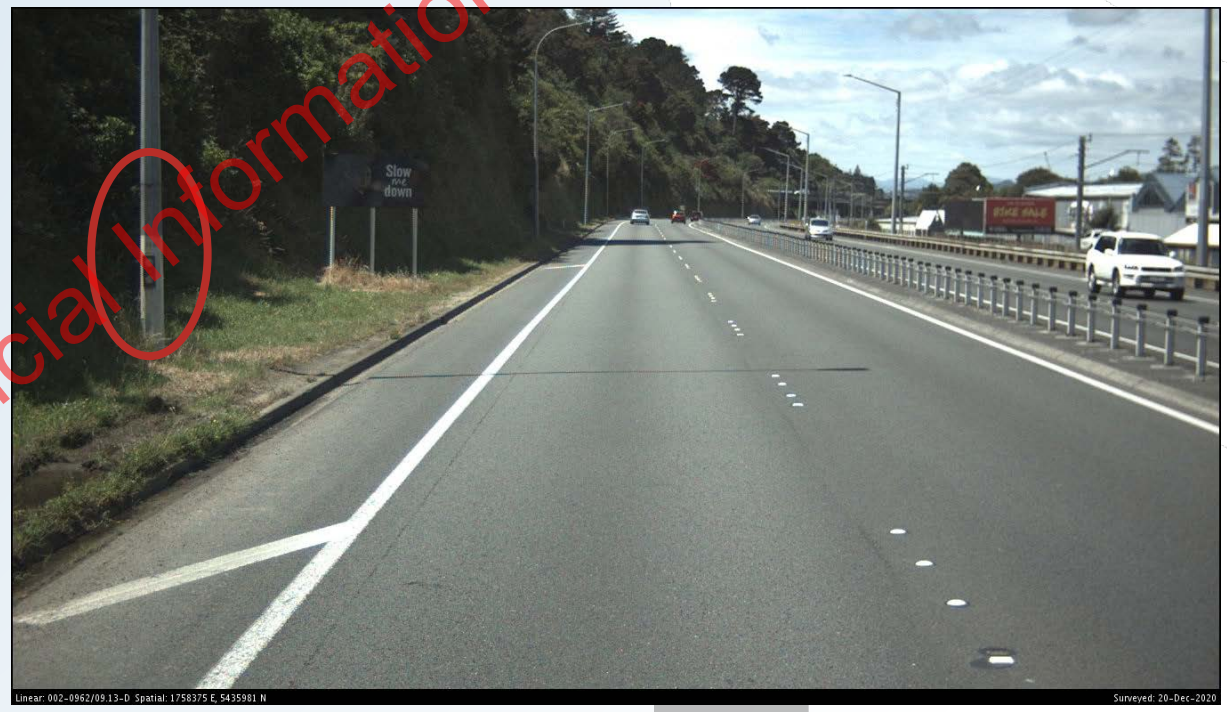
- SH reference position
  - RP 002-0962/15.08-D
- Measurements from cowling to:
  - Edge of carriageway
    - 2005 mm
  - Buffer line
    - 3135 mm
  - Edge line
    - 3735 mm
- Shoulder width
  - 1730 mm
- Lane width
  - 3500 mm



*Monitoring equipment was attached to column circled in red

No buffer on straight

- SH reference position
  - RP 002-0962/09.13-D
- Measurements from cowling to:
  - Edge of carriageway
    - 2280 mm
  - Edge line
    - 3740 mm
- Shoulder width
  - 1460 mm
- Lane width
  - 3500 mm



*Monitoring equipment was attached to column circled in red

Buffer on curve

- SH reference position
  - RP 002-0962/14.38-I
- Measurements from cowling to:
  - Edge of carriageway
    - 400 mm
  - Buffer line
    - 1750 mm
  - Edge line
    - 2220 mm
- Shoulder width
  - 1820 mm
- Lane width
  - 3500 mm

*Monitoring equipment was attached to column circled in red

No buffer on curve

- SH reference position
  - RP 002-0962/08.87-D
- Measurements from cowling to:
  - Edge of carriageway
    - 2400 mm
  - Edge line
    - 3900 mm
- Shoulder width
  - 1500 mm
- Lane width
  - 3500 mm

*Monitoring equipment was attached to column circled in red

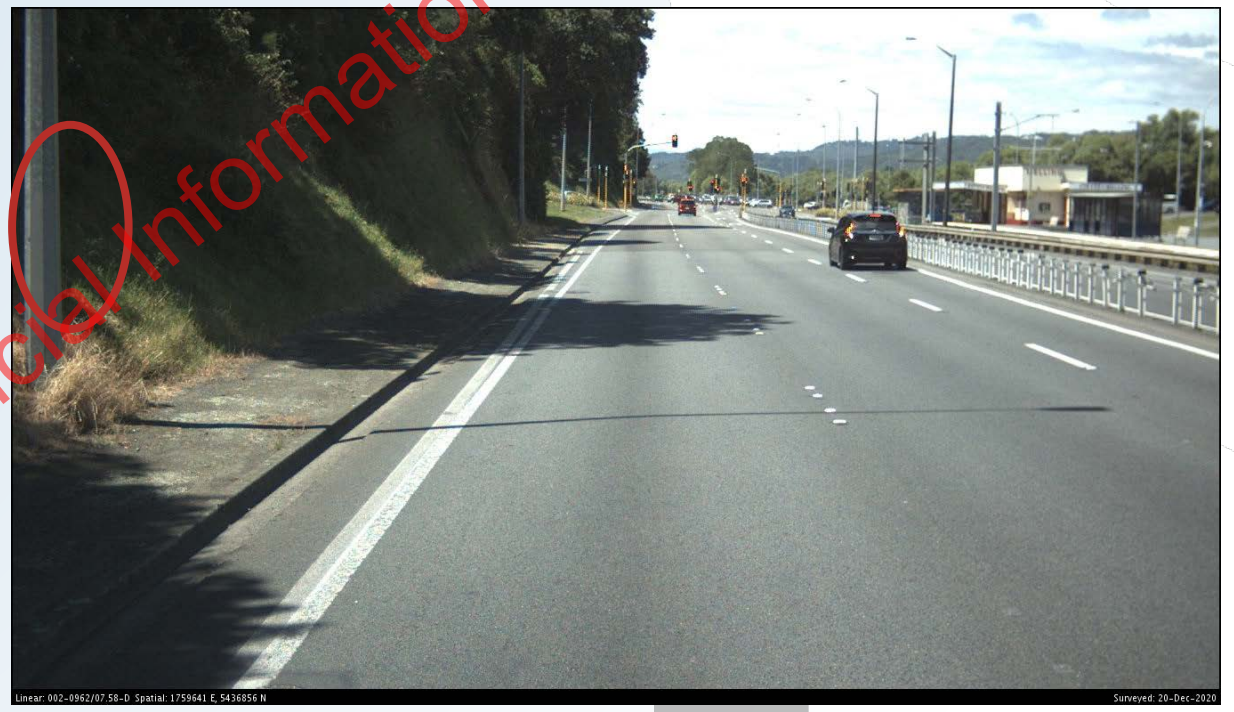
Green block on straight

- SH reference position
  - RP 002-0962/06.36-I
- Measurements from cowling to:
  - Edge of carriageway
    - 640 mm
  - Edge line
    - 1300 mm
- Shoulder width
  - 660 mm
- Lane width
  - 3000 mm

*Monitoring equipment was attached to column circled in red

No green block zone on straight

- SH reference position
  - RP 002-0962/07.58-D
- Measurements from cowling to:
  - Edge of carriageway
    - 2140 mm
  - Edge line
    - 2860 mm
- Shoulder width
  - 720 mm
- Lane width
  - 3500 mm



*Monitoring equipment was attached to column circled in red

Data analysis

- A total 2376 cyclists were observed passing the monitoring equipment during the data collection period.
- Of these a total of 880 (37 %) cyclists were passed by a vehicle in the near lane as they cycled in front of the monitoring equipment
- It has been assumed that the cyclists' handlebars were approximately 700 mm in width when determining the gap between the right-hand side of the cyclist and the left-hand side of the vehicle.
- Significant differences were established through the implementation of t-tests

Results (overall)

Site	Cyclist average distance left of edge line (m)	Vehicle average distance right of edge line when cyclist present (m)	Average passing distance between cyclist and vehicle (m)	Vehicle average passing speed (km/h)*
Buffer on straight	1.13	1.21	1.63	73.8
No buffer on straight	0.94	1.08	1.33	79.2
Buffer on curve	1.15	1.20	1.65	58.9
No buffer on curve	1.12	1.20	1.62	86.8
Green block on straight	0.48	0.84	0.61	43.4
No green block on straight	0.43	1.13	0.86	53.2

*All sites had 100 km/h posted speed limits

Results (significant differences passing distance)

Site	Average distance between cyclist and vehicle		Significantly different (t-test)
	N.	m	
Buffer on straight	245	1.63	Yes, $t(66.86) = 8.58$, $p < 0.01$
No buffer on straight	40	1.33	
Buffer on curve	376	1.65	No, $p > 0.05$
No buffer on curve	45	1.67	
Green block on straight	135	0.59	Yes, $t(43.52) = -4.217$, $p < 0.01$
No green block on straight	38	0.89	

Results (significant differences passing speed)

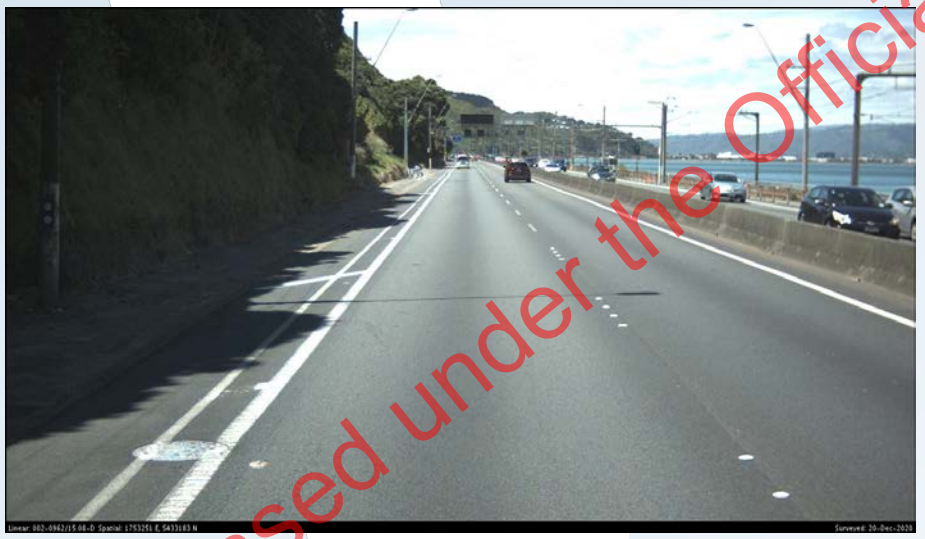
Site	Average passing speed between cyclist and vehicle		Significantly different (t-test)
	N.	km/h*	
Buffer on straight	245	73.8	No, $p > 0.05$
No buffer on straight	35	79.2	
Buffer on curve	376	58.9	Yes, $t(418) = -6.524$, $p < 0.01$
No buffer on curve	44	86.8	
Green block on straight	135	43.4	Yes, $t(118.492) = -2.350$, $p < 0.05$
No green block on straight	38	53.2	

*All sites had 100 km/h posted speed limits

Conclusions (buffer on straight)

- The results indicated that the greatest effect on distance between cyclists and vehicles, was with the implementation of buffers on straight sections of carriageway where passing vehicles, on average, gave 0.3 m more space when the buffer was present.

- While vehicles were approx. 6 km/h slower when passing with a buffer this difference was not significant.

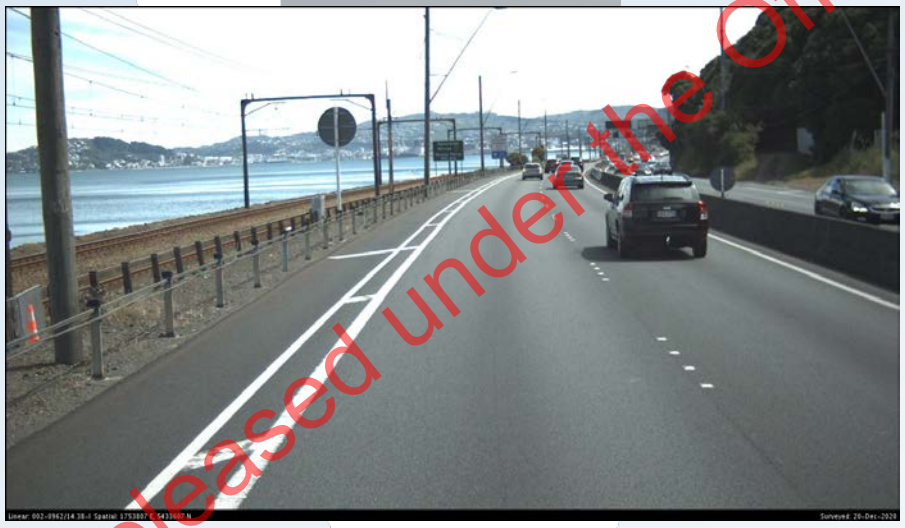


Buffer on straight

No buffer on straight

Conclusions (buffer on curve)

- The results of the indicated there was no significant difference in distances between cyclists and vehicles on curves which is likely a function of the right-hand horizontal curve.
- However, the distances seen on curves were still greater than at the ‘No buffer on straight’ site, meaning vehicles were given more room.
- Vehicles were significantly slower to pass cyclists when the buffer was present by approx. 30 km/h

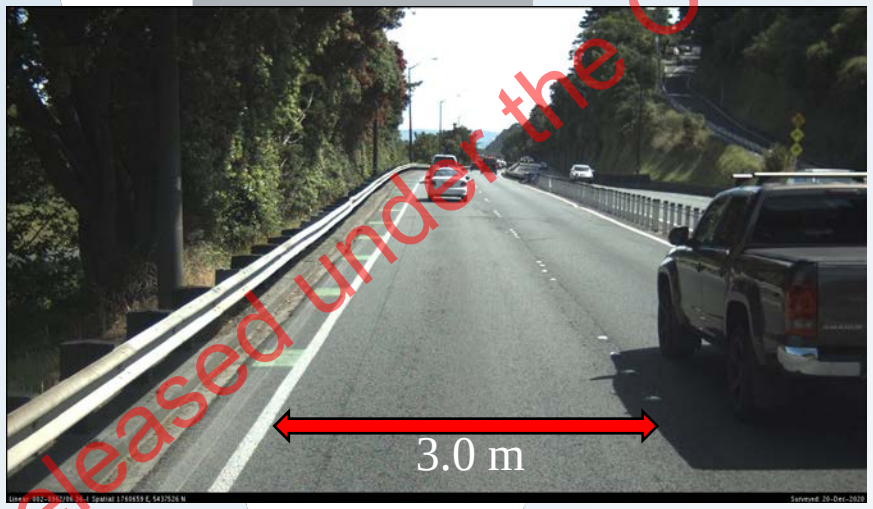


Buffer on curve

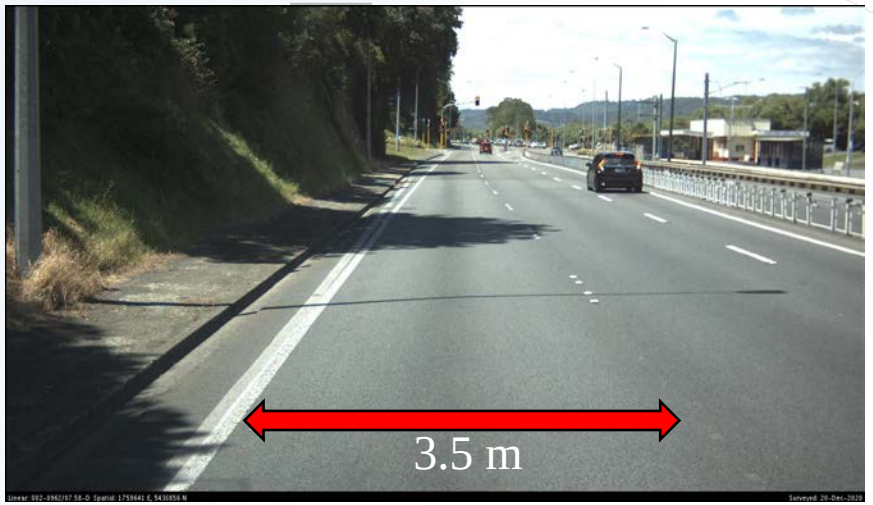
No buffer on curve

Conclusions (Green blocks)

- At the ‘Green block on straight’ site drivers had less lane width, 3.0 m as opposed to 3.5 m, compared to the control site.
- Once lane width was controlled for (taking away the additional 0.5 m) drivers at the ‘Green block’ site moved themselves more to the right by 0.26 m within their own lane (relative to the control site) which is about 43 % of the available space between the vehicle and the edge of their lane.
- This indicates that vehicles were giving up more of their lane to give more room to cyclists.
- The results showed that vehicles were approx. 10 km/h slower passing cyclists when green blocks were present than when they were not.



Green block on straight



No green block on straight

Conclusions (Green blocks)

- The importance of increasing the size of the passing gap between cyclists and vehicles at these very narrow locations, i.e. green block sites, is highlighted by previous research that cyclist are less accepting of passing distances the smaller the distance becomes. (See image to right).

- Acceptance is particularly low for passing distances of less than 1 m.

Table 4.11 Overall rider acceptance of overtaking gap by range

Road type	Overtaking gap (m)	Observed	Buttons	Acceptance	Cumulative acceptance
Urban <=60km/h	0.00 – 0.49	4	2	50%*	50%
	0.50 – 0.99	57	11	81%	79%
	1.00 – 1.49	483	32	93%	92%
	1.50 – 1.99	1195	27	98%	96%
	2.00+	1818	9	100%	98%
Major Arterial and Rural >60km/h	0.00 – 0.49	0	0		
	0.50 – 0.99	7	3	57%*	57%
	1.00 – 1.49	78	10	87%	85%
	1.50 – 1.99	346	4	99%	96%
	2.00+	750	4	99%	98%

Balanovic, J., Davison, A., Thomas, J., Bowie, C., Frith, B., Lusby, M., ... & Burton, J. (2016). Investigating the feasibility of trialling a Minimum Overtaking Gap law for motorists overtaking cyclists in New Zealand. *NZ Transport Agency Internal Report*.

Recommendations

- Implement buffered markings, where practicable, in high-speed, high volume environments as an effective, high value treatment
  - For consistency, a continuous treatment is recommended (i.e. at curves and straights) as there is no apparent negative impact and continuity is desirable to promote consistent behaviour

- As there is effectiveness in these high-value treatments, carry out further studies around buffers on curves (especially left-hand horizontal curves), the implementation of ‘Green blocks’ at narrow locations where site conditions and dimensions can be better controlled, and any potential benefit from both markings working together (e.g. see next slide)

Potential trials

Shoulder type	Example shoulder widths	Study treatment type	Possible gaps in knowledge
Narrow	Less than 0.8 m	Green blocks	Confirmation at same vehicle lane width
Medium	1 m - 1.5 m range	Buffer zone + Green blocks OR Buffer zone alone (wider cycle lane)	Test benefit of dual marking vs buffer alone
Wider	1.5 m or more	Buffer zone	Confirm the space holds for left-hand horizontal curves

Thank you

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