

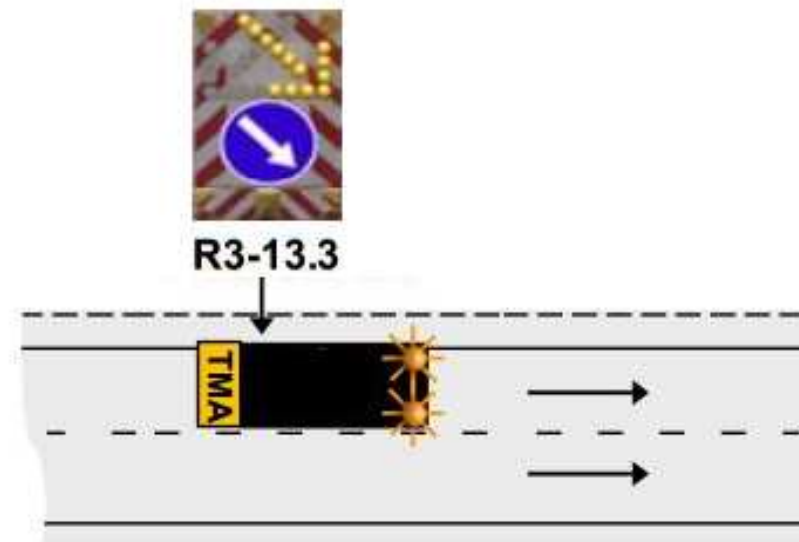
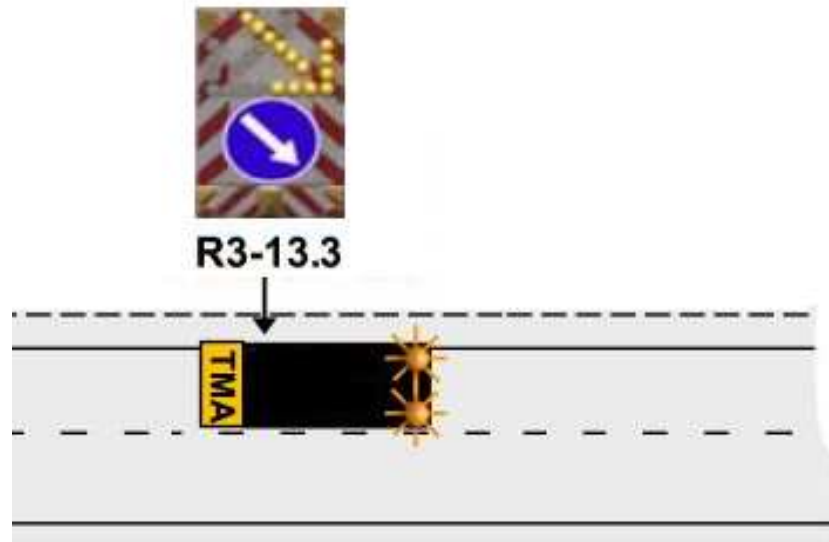


Advanced warning VMS: Does it work safely in New Zealand conditions?

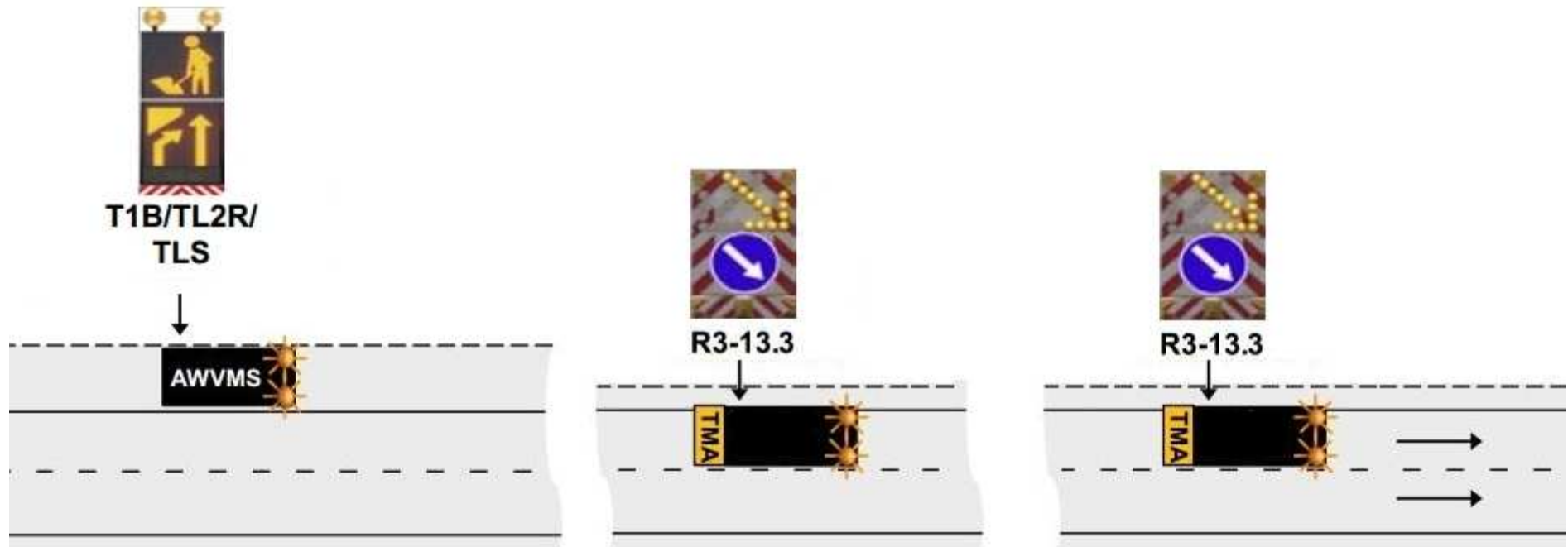
Jared Thomas, Grace Rive, Joel Burton, Kate Mora (Opus Research), Dave Allen (AMA), Fergus Tate (NZTA)

Contact: jared.thomas@opus.co.nz

Truck-Mounted Attenuator (TMA) Site layout (no advanced warning VMS)



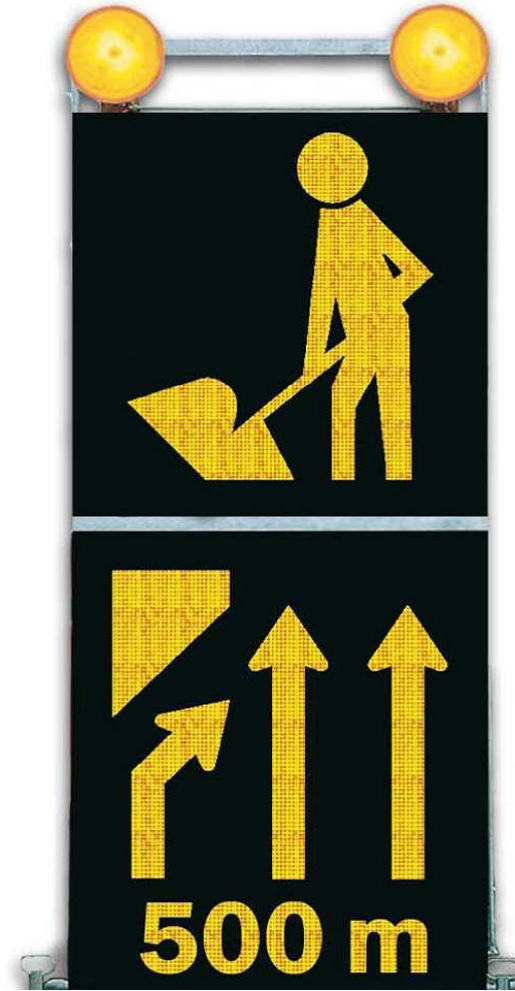
TMA site layout with Advanced Warning VMS (AWVMS)



How do we best inform the driver and maximise overall safety?



Attenuator Signage



Advanced warning signage



Attenuated truck warnings

- Purpose – Provide evidence base around:
Where and when should we use AWVMS?
 - What do the customers (road users) prefer?
 - What do experts prefer?
 - What improvements are desirable?
 - Is there enough shoulder space for advanced warning vehicles and their drivers?
 - What does the accident history tell us?



Attenuator Safety Performance

- 28 Crashes involving attenuators on AMA in 10 years
 - 2 serious
 - 3 minor
 - 23 non-injury
- 1 serious within site (roadmarking)
- In all but one case vehicle was in a lane

Wellington case study evidence for AWWMS

	BEFORE AWWMS (5 years)	AFTER AWWMS (5 years)
Wellington Study		
Attenuator crashes	8	3
AWVMS Crashes	-	0



What do customers prefer?

- Structured interviews conducted with 20 drivers

	Male	Female
15-24 years	1	1
25-64 years	9	7
65+ years	1	1

- Participants shown two video scenarios (counterbalanced design)
 - With AWVMS
 - Without AWVMS
- Structured questions for both conditions:
 - Perceived safety, Comprehension, Anticipated behaviour
 - Possible improvements and preferred situational use



Findings - Summary

- Set-up with AWWMS consistently favoured:
 - 95% preferred AWWMS set-up overall
 - 95% also perceived AWWMS as the safer setup
 - 55% found the AWWMS easier to understand (40% rated them both the equal – with 5% finding the TMA easier)
 - 65% drivers reported attempting to merge earlier in the AWWMS set-up (as soon as it was safe to do so)




Why AWVMS preferred?

- Earlier warning for drivers
- Allows safer merge behaviour
- Increased clarity

“The second one [with the VMS warning is easiest to understand] because it gives you an earlier warning and is clearer because the sign shows the actual lanes merging.”

“Even though you see the arrow in the first one [without VMS warning], you get an even earlier warning [in the second version with the VMS warning] and it shows the actual lanes merging. It’s clearer than just the arrow [on the back of the truck] I think.”




Recommendations – Use of AWVMS

- Maximise use of AWVMS sites where appropriate
- Particularly conditions like:
 - Heavy traffic (where it can be harder to merge)
 - Roads with limited sight distance (tight, narrow, curved or steep roads)

“[I prefer] the advanced warning video as it is clear that your lane is ending. The signage is clearer and gives you more warning time.”

“With the second one [with VMS warning], you get that additional warning that shows you exactly what you have to do before you have to do it. It just gives you more time to prepare yourself, especially if it’s heavy traffic in the other [right-hand] lane.”



Signage Improvements - Customers

- Consider amendments to existing signage
 - Replacement of RG17 signs
 - Additional information on attenuator signs
 - Addition of “works end” signage

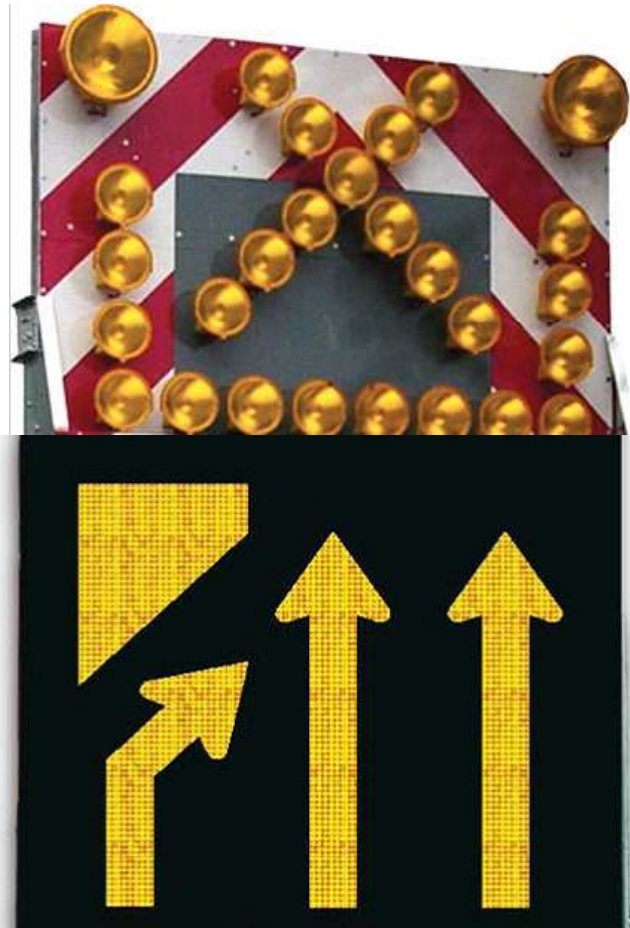
“... The blue arrow is in the road code in other contexts [which could lead to some confusion].”

“People may be confused by the arrow as it’s not obvious that it means move to the other lane.”

“Confusion may arise when they want to return to their original lane after the second truck as there is no ‘works end’ sign.”



Signage improvements - Experts



- Experts also desire signage improvements on attenuators
- Flashing arrows could be a cause of concern:
 - May look like the vehicle is indicating
 - Flashing too much at night
- Use of Text and Pictures (arrows):
 - Use text or alternate between “Keep Right” or “Keep Left” text and picture of lane change

Example suggestion: New sign setup for Attenuators



Education Improvements – Customers

- Consider educational campaigns – signage and required behaviours

“Some education for drivers on attenuated trucks would be helpful, particularly explaining what the arrows on the attenuator trucks mean. I guess it’s in the road code, but who reads the road code unless they’re... [going for a test]”

“Yes [I did find the set-up easy the first time], but for me it was more about seeing what the other drivers were doing and following their example rather than understanding what the signs meant.”



Education Improvements – Experts

- More info on TMAs (e.g. “Riding in pairs”)
- Road Code
 - Only limited NZ Road Code advice on attenuators:
“Slow down and obey the arrow”
 - Nothing about AWWMS

Lane change signs


When roads or lanes are being maintained, an attenuator (truck with message board on it) is often used. Its purpose is to direct traffic to an open lane in advance of roadworks. Slow down and obey the arrow.



Attenuator



Distance between vehicles Improvements – Customers and Experts

- **Customers** – preferences around maximum distances:
“If the distance between the trucks, or the truck and the advanced warning trailer, are too great it could confuse people. They see the warning and are not told to continue staying right. I wouldn’t naturally stay right after the first truck.”
 - **Experts** - Actively observed that where the TMA was not visible (e.g. due to a curve in the road) the AWVMS was far less successful in shifting traffic from the lane immediately (importance of CSD)
 - Max allowable separation from AWVMS = 1600m (extends to 3km if no available shoulder; COPPTM 4th Ed.)
- 

What do experts prefer?

- 5 structured interviews with expert practitioners
- Expert improvements match customer preferences
- Experts do prefer AWVMS
- Self-report on observed effectiveness = 66% shift lanes immediately (corroborates Customer finding)

“Some still wait, but...you may have a group of 5 cars that come, 3 move and 2 carry on”

- Key issue/barrier is the shoulder space available (to ensure safe clearance for an unprotected AWVMS utility vehicle)

“Great concept – Wrong network”




Minimum shoulder space requirements

- AMA Network study
- Particular concern regarding trucks (perceptions of safety) *“...should I move over a bit?”*
- Moving too far from edgeline can cause an issue – as traffic cannot see

“I feel comfortable being a metre away”

	Minimum shoulder space available	
	1m	2m
Amount of network with: Shoulder space (to live lane) Clear site distance Safe egress for vehicles	80%	29%
Perceived safety of AWVMS vehicle driver	66%	100%



Recap so far...

1. Safety statistics are better with AWVMS
 2. Customers prefer AWVMS for most conditions
 3. Experts also prefer AWVMS –where there is space
- But...there is a concern around shoulder space availability on the New Zealand road network
 - Desire to keep AWVMS vehicle away from live lane (particular issue around mobile sites)



Safety Performance – Shoulder Safety

Crashes (over last decade)	Crashes involving vehicles on shoulder	Crashes involving attenuators
Crash frequency	24	28
Crash severity		
Serious injury	1	2
Minor injury	1	3
Non-injury	22	23

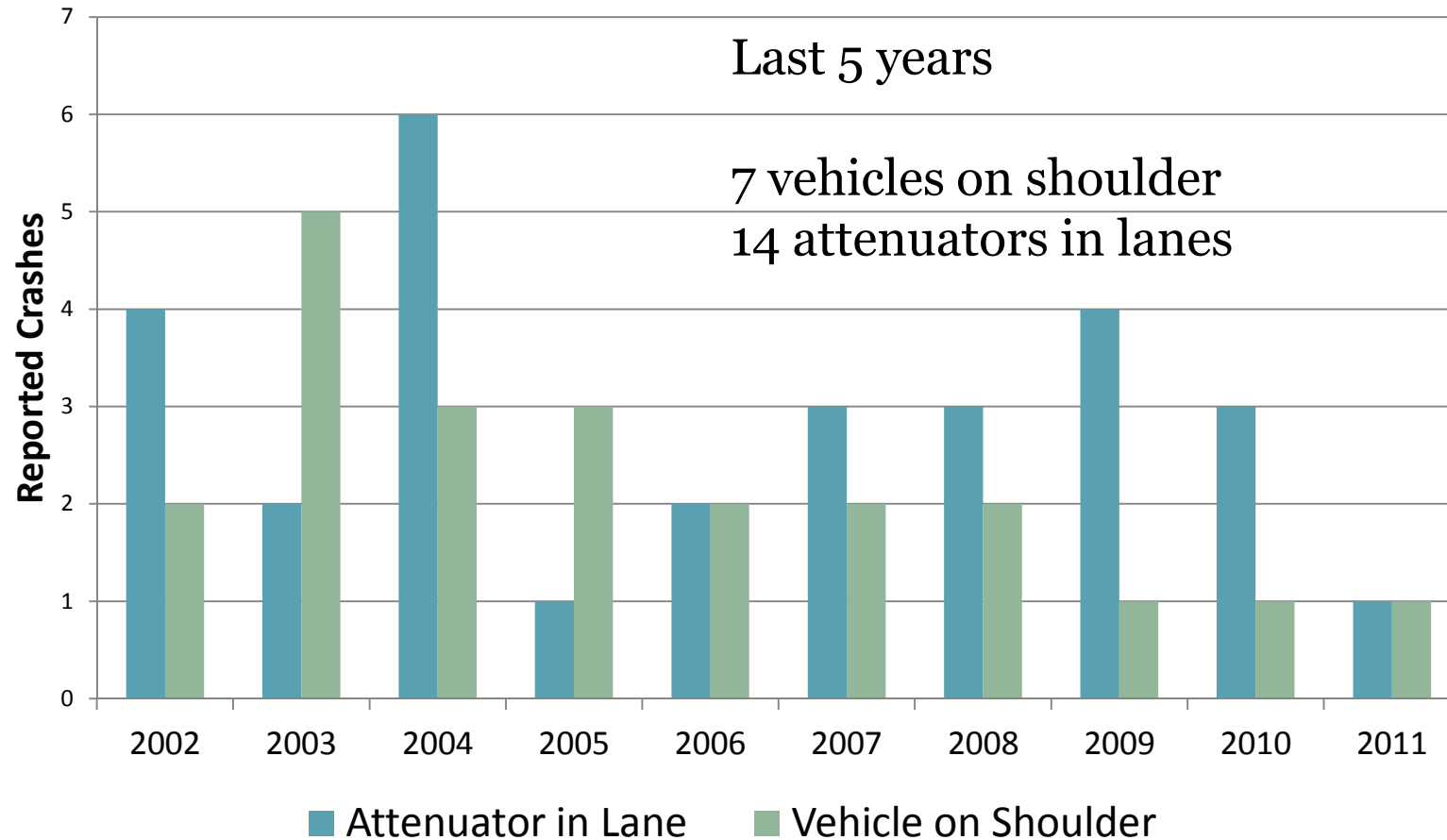
Vehicle on shoulder crash characteristics:

- 6 cases involved hitting open door
- 2 cases described as side swipe with vehicle continuing on
- 2 cases involved “moving onto shoulder”

No AWWMS vehicle hits



Comparison: Recent years



What is the minimum acceptable clearance from the live lane for AWWMS Utes ?

Lane position study to examine:

1. Whether drivers do encroach on the shoulder?
2. How close to the shoulder do they typically drive?
3. Which driving conditions are likely to make drivers closer?



Lane position study

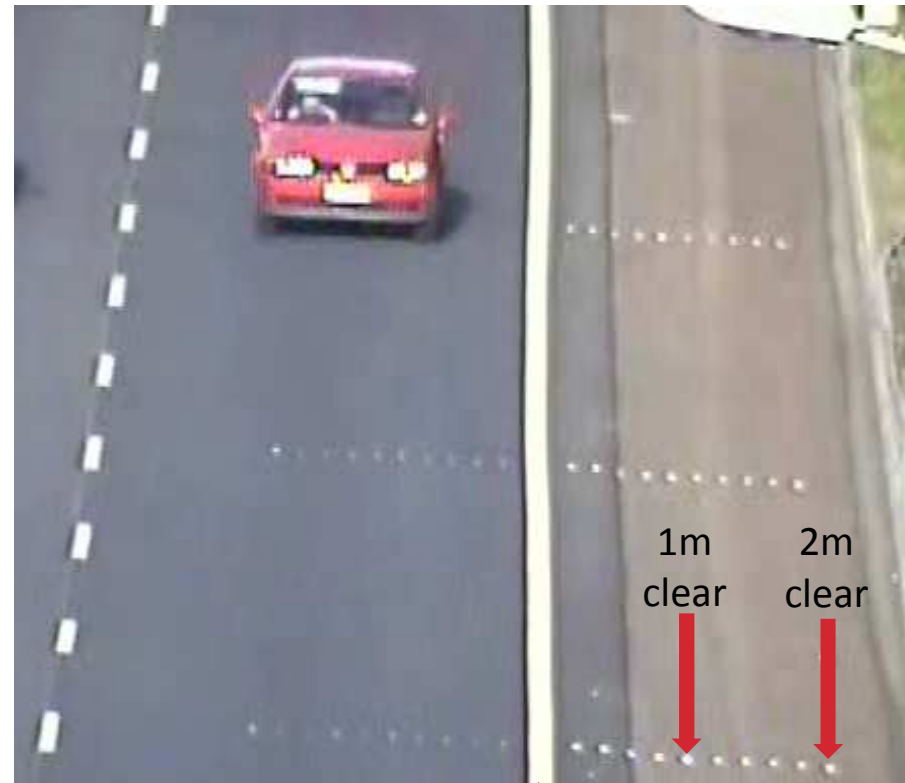
- Method
 - Video footage of 1000 vehicles examined
 - Markings used to determine space
 - Good inter-rater reliability (between .8 and .84)

Finding 1

- No drivers encroached on the shoulder
- No drivers encroached on the shoulder edgeline

Finding 2

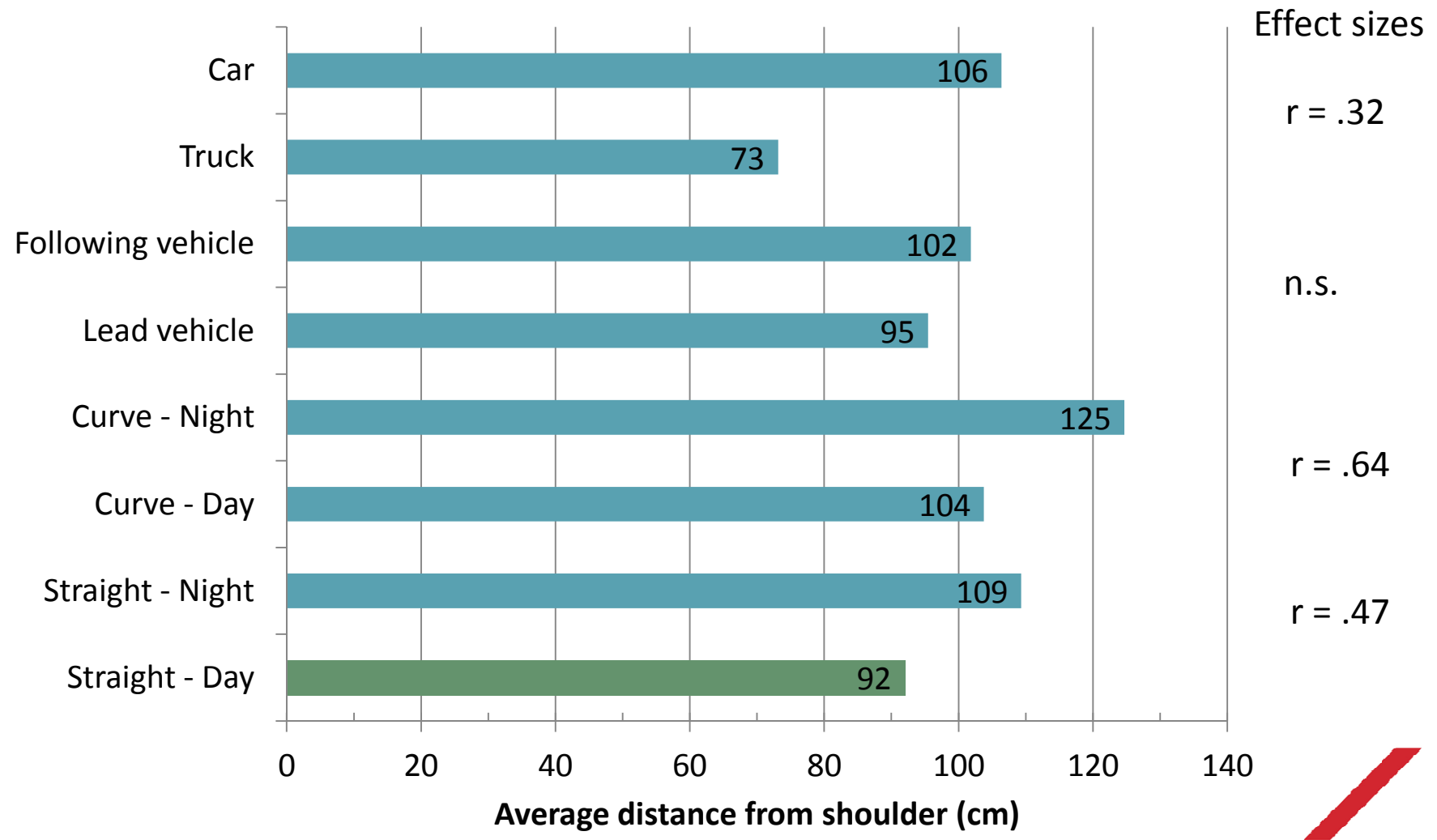
- **1 metre** is the average and most common clearance distance from the shoulder
- Only 1.7% of drivers drove immediately beside the edgeline



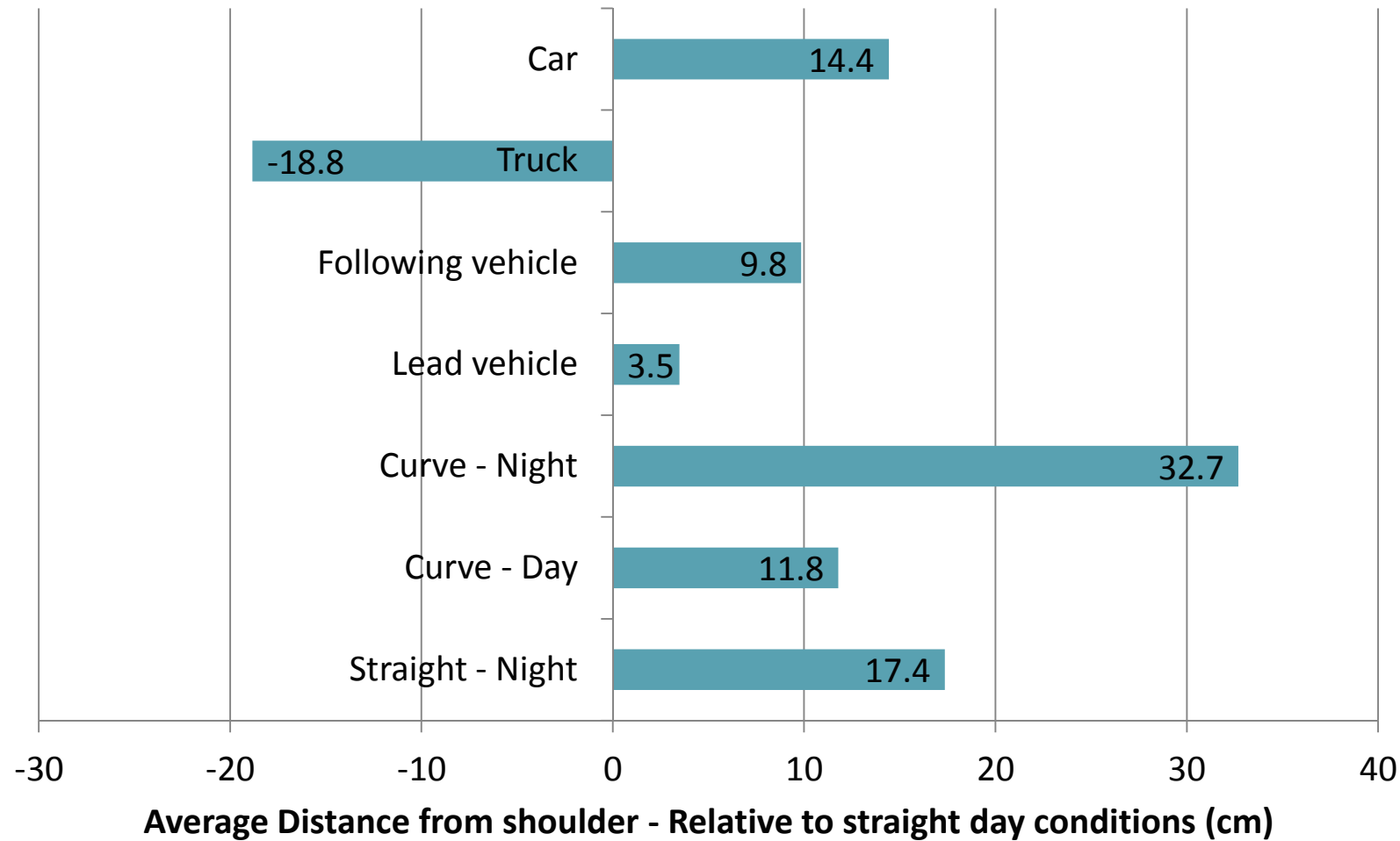
Most drivers
No drivers



Finding 3: Clearance from shoulder in different conditions



Clearance – Relative to Straight Day Conditions



Overall key findings

- Safety benefits of AWWMS include:
 - Better overall safety statistics (shoulder vs TMA vehicle crashes)
 - Customers and Expert value the advanced warning
 - Improved driver comprehension
 - Improved reported behaviour (i.e. 3 in 5 drivers early lane shift)
- Improvements recommended consistently by both Customers and Experts include:
 - Improved signage
 - Improved education (e.g. “riding in pairs”)
 - Distance between vehicles
- Evidence provided to underpin any decision around minimum clearance for AWWMS driver from live traffic

