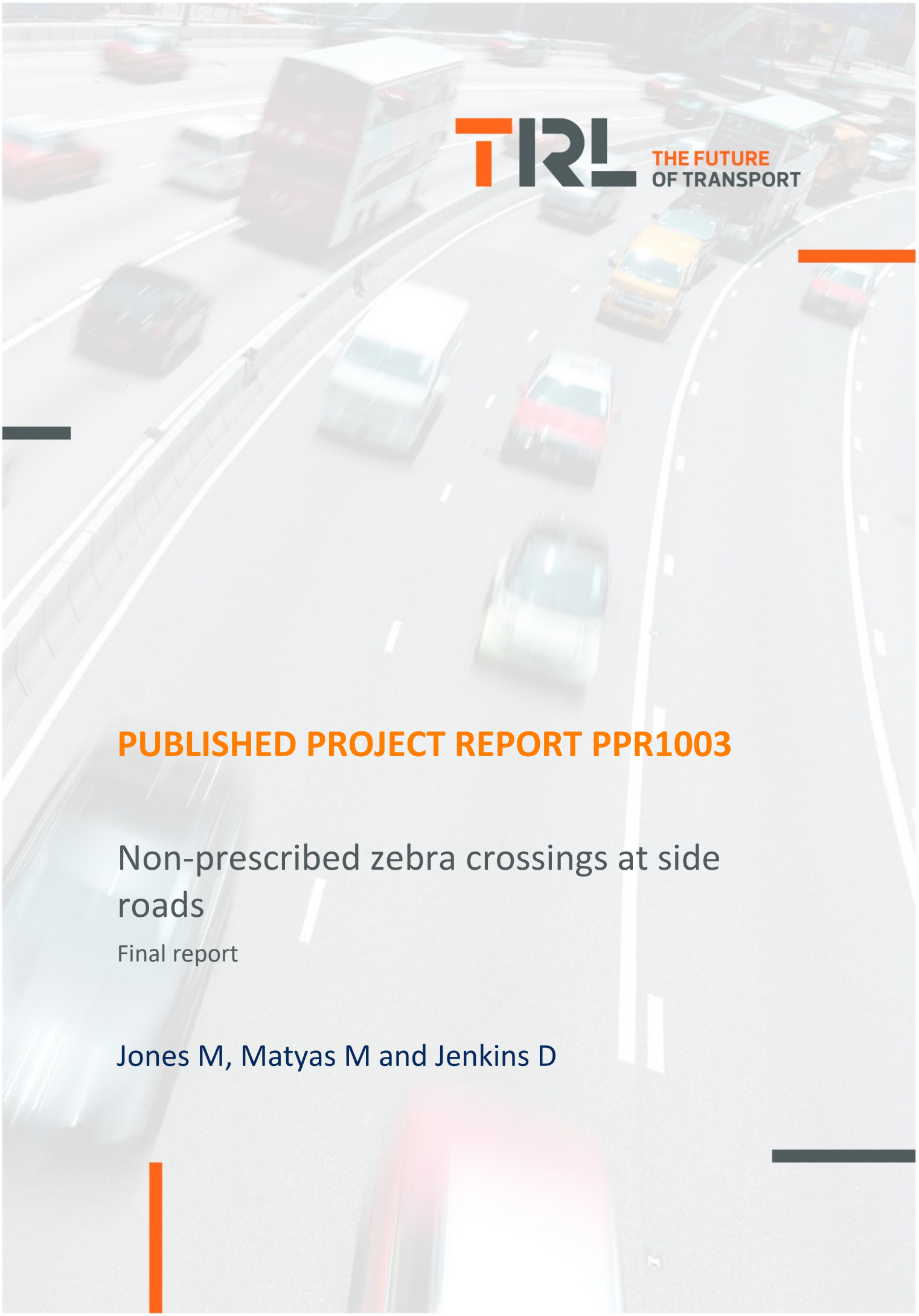

THE FUTURE OF TRANSPORT

PUBLISHED PROJECT REPORT PPR1003

Non-prescribed zebra crossings at side roads

Final report

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Report details

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Executive Summary

Background

Transport for Greater Manchester (TfGM) commissioned TRL to undertake a programme of research into the use of non-prescribed zebra crossings at side roads. A prescribed zebra crossing has black and white stripes with give way lines, yellow globes on striped posts, and a line of studs and zigzag markings. A non-prescribed zebra crossing uses the black and white markings without all the other features; thereby allowing the crossing to be installed in the pedestrians' desired walking line, directly across the mouth of a junction.

A research programme was designed, which followed a sequence of seven distinct studies, beginning with analysis of collision statistics, progressing through user surveys and interviews, simulation studies and culminating in two on-street trials. Earlier stages therefore informed later stages and helped to manage risk. This report provides a summary and analysis of the collective findings from this programme of work in order to develop recommendations.

Findings

The propensity of drivers to give way increased significantly in the two on-street trials; the majority of drivers gave way *with* the crossing, while less than half did so without. Improved willingness to give way was also found in surveys and the simulator study. However, compliance when turning into the side road was substantially lower than when turning out, especially when turning right, which was also indicated in earlier studies. Crucially, while a significant level of non-compliance remained, this did not increase the observed level of conflict between road users during the on-street trials.

User surveys found that pedestrians are more likely to cross where a non-prescribed zebra crossing is provided in comparison to having no crossing.

Investigation of existing non-prescribed zebra crossings found no evidence that using a simplified crossing with only the zebra markings would have significantly greater risk than using the full range of features. A reaction time study comparing zebra markings and a range of possible alternative patterns concluded that zebra markings were the most easily recognised.

Qualitative feedback from user surveys, in particular interviews with the disability groups, identified a number of user concerns such as identifying and judging vehicles approaching from behind on the main carriageway, identifying and following the path of the crossing, traffic speed and noise, and large vehicles. These will need to be mitigated through appropriate site selection, design details and potentially, awareness raising and training.

Based on the research undertaken in this programme, it is recommended that regulatory approval is sought to implement crossings at a larger number of sites for longer term monitoring with a wider range of street environments. Noting that the two sites used in the current study have comparatively low traffic flows, it would be prudent to develop a phased approach, beginning with validating the findings from the current trials at a larger number of similar sites, before progressing to sites with a wider range of traffic flows and speeds and physical characteristics.

Table of Contents

Technical Annexes (published as separate documents)

PPR1004 Non-prescribed zebra crossings at side roads. Technical Annex 1: Analysis of collision records at existing sites. Hammond J. and Simms G. 2019

PPR1005 Non-prescribed zebra crossing at side roads. Technical Annex 2: User surveys at existing sites. Verwey L., Novis K., Wallbank C. and Stuttard N. 2020

PPR1006 Non-prescribed zebra crossing at side roads. Technical Annex 3: Effectiveness of alternative markings. Novis K., Hyatt T., Stuttard N. and Wallbank C. and Verwey L. 2020

PPR1007 Non-prescribed zebra crossing at side roads. Technical Annex 4: Road user perceptions and understanding. Blunden A., Gupta B., Matyas M., Mazzeo F., Wallbank C. and Wardle A. 2021

PPR1008 Non-prescribed zebra crossing at side roads. Technical Annex 5: Implications for people with disability. Blunden A., Gupta B., Verwey L., Butler, R. and Wallbank C. 2021

PPR1009 Non-prescribed zebra crossing at side roads. Technical Annex 6: Driver simulator trials. Jenkins D., Ramnath R., Stuttard N. and Chowdhury S. 2021

PPR1010 Non-prescribed zebra crossing at side roads. Technical Annex 7: Observations of conflict and giving-way during on street trials. Greenshields S., Ognissanto F., Lee R. and Macgregor E. 2021

1 Introduction

1.1 Background to the research

In 2019 Transport for Greater Manchester (TfGM) commissioned TRL to undertake a programme of research looking at the use of non-prescribed zebra crossings at side roads. This aimed to provide the evidence necessary to support an application to the Department for Transport (DfT) for regulatory approval for further, longer-term trials.

The markings, equipment and signs used to denote a zebra crossing in the UK are prescribed in legislation: the Traffic Signs Regulations and General Directions[1]. Key differences between a prescribed and non-prescribed zebra crossing are shown in Table 1. A prescribed zebra crossing is indicated by a series of alternate black and white stripes on the carriageway with give way lines on either side; a yellow globe mounted on a black and white striped post, positioned on the pavement at each end of a zebra crossing (Belisha beacon); and the crossing area is marked with a line of studs and zigzag markings. While there is no specified minimum distance that a zebra should be placed from a junction, in practice the need for a minimum of two zigzags limits this to about 4.8m.

A non-prescribed zebra crossing uses the prescribed black and white markings without all the other features of the prescribed crossing. By not including the zigzag markings, and the consequent minimum set-back distance, it is possible to install the crossing on pedestrians' desired walking line, directly across the mouth of the junction. The simplified design requirements, in particular not including illuminated beacons, would also reduce the implementation and maintenance costs of providing new crossings.

Table 1: Key differences between a prescribed and the non-prescribed zebra crossing considered the trial

Design feature	Prescribed zebra crossing	Non-prescribed zebra crossing
Crossing markings	Black and white stripes and give way markings	Black and white stripes Give way markings
Peripheral markings	Line of studs Zigzag markings	No zigzag markings
Set-back distance from junction	The requirement for at least two zigzag markings creates a minimum set-back distance of around 4.8 meters	No minimum distance, could be flush with the end of the side road
Additional equipment	Yellow globe on a black and white striped pole (Belisha beacon)	No beacon

[1] See www.gov.uk/government/publications/traffic-signs-regulations-and-general-directions-2016-an-overview

Both prescribed and non-prescribed crossings are intended to give pedestrians wishing to cross the side road priority over vehicles; this applies to vehicles on the side road approaching the junction, and to vehicles on the main road wishing to turn into the side road. Drivers (and to a lesser extent pedestrians) have a short time in which to determine what to do when confronted with an unfamiliar road layout. The key to effective road markings is the ability to quickly and accurately convey the intended message to road users, so that both drivers and pedestrians can intuitively take appropriate action.

Figure 1: Example of a non-prescribed zebra crossing at one of the trial sites (from video)

1.2 Summary of research programme and research methods used

The research programme was designed to answer a set of research questions that were defined at the start to meet TfGM's objectives. A bespoke methodology was designed to answer each research question, involving desk-based research, analysis of collision statistics, user surveys and interviews, simulation studies and video observation of two on-street trials. The research was undertaken as a set of individual studies, sequenced so that the findings of the earlier phases could inform the later ones (see Figure 2). This allowed for any risks identified to be taken into account when the on-street trials were undertaken (as the last of the seven studies), thereby minimising overall trial risks.

The earlier studies were focused on aspects of the design of the proposed crossing. Because fully compliant zebras cannot be used close to the mouth of a side road junction, any design used at that location would be considered non-prescribed. Nonetheless, there are different non-prescribed versions of the zebra crossing that could be considered, as well as different types of markings from the black and white stripes on a zebra crossing that could be used.

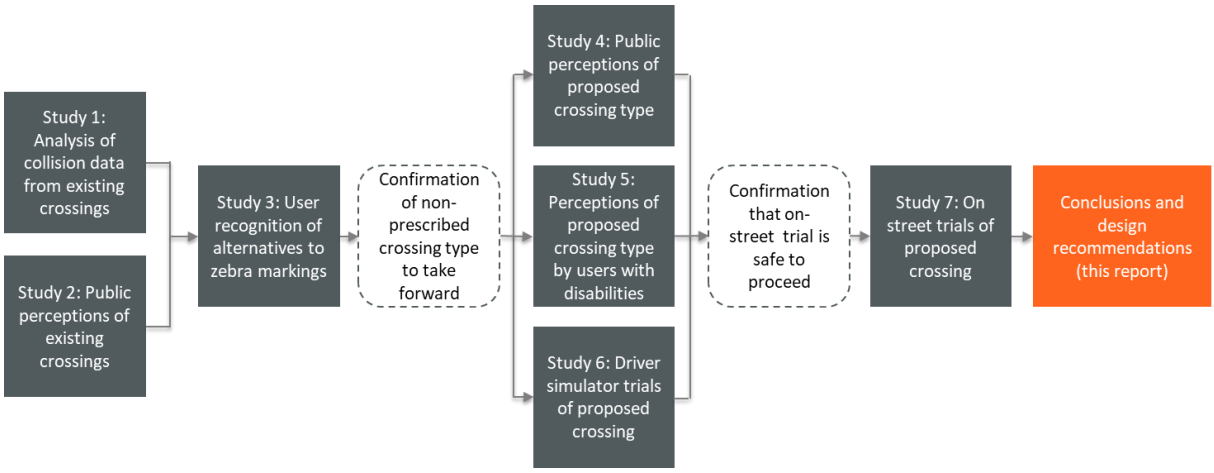


Figure 2: Sequence of studies in the research programme

As examples of existing non-prescribed crossings can already be found across the UK, in particular on private roads in retail and industrial parks, the first study (**Study 1**) investigated road collision data (using Stats 19) at a sample of sites where the crossing is at- or close to-the mouth of a side-road junction. While all the crossings identified were non-prescribed, some had the main zebra crossing features, including Belisha beacons, while others had only the zebra markings. This enabled a comparison to be made between the 'full' zebra crossings with all the features and the simplified 'non-full' crossings that only had the markings. The purpose of this analysis was to identify any specific risks from positioning a zebra type crossing close to the mouth of the junction or from using a simplified 'non-full' crossing design.

In **Study 2**, a sample of the sites with non-prescribed crossings identified in Study 1 was used to undertake user surveys to investigate road user perceptions of safety, convenience, and priority at side-road crossings and how they are influenced by whether the 'full' design or a simplified ('non-full') version is used.

There are a number of reasons why it would be expected that the crossing design taken to trials would use the familiar Zebra markings, as these are widely used both in the UK and elsewhere for this purpose. Side road crossings are very commonly marked with stripes across Europe. Nonetheless, this research provided an opportunity to consider whether alternative markings might have advantages over the familiar markings. In **Study 3** reaction-time tests were undertaken to see how users respond to conventional zebra markings compared with a range of potential alternative types of marking to assess how users recognise, and would respond to, different types of markings. Following confirmation of the marking types to be taken forward, the design of the proposed non-prescribed crossing was finalised, and drawings prepared to be taken forward to the next stages of this research programme.

During **Study 4**, online user surveys involving simulated videos and images were undertaken with members of the public (drivers and pedestrians) to assess how people interpret the meaning of the proposed non-prescribed zebra crossing markings, their understanding of who has priority, and their perceptions of safety and convenience.

As a complement to Study 4, during **Study 5** user research was undertaken with individuals with a range of disabilities (vision, hearing, mobility) and with representatives of organisations

that work with people with mental health conditions and learning disabilities. This investigated whether the proposed crossing had any specific implications for those groups.

In **Study 6**, TRL's driving simulator was used to conduct trials with drivers to assess how they would behave (i.e., their propensity to give way) when presented with varying numbers of pedestrians as they turned in and out of side road crossings in a simulated street environment. The proposed non-prescribed zebra crossing and one other marking type were compared with an un-treated side road junction with only standard give-way markings. These trials provided a safe environment in which behaviour and understanding of priority could be investigated before on-street trials commenced.

The research concluded with on-street trials at two sites (**Study 7**). Video cameras were used to record how road users behaved over two-week periods with and without the non-prescribed markings present. Analysis of a sample of crossing movements was used to compare how interactions between pedestrians and vehicles changed, in particular whether there was any increase in conflict, and whether there was a change in the propensity of drivers to give way.

The seven conducted studies and the methods used are summarised in Table 2. Details of the methodology and findings from each individual study are provided in the individual TRL research reports that form the Technical Annexes to this report (see list on page ii).

Table 2: Study research questions and methods

Study name and number	Main research questions answered	Methods used	Tech. ann. #
Study 1: Analysis of collision data from existing crossings	What is the collision record at existing non-compliant zebra crossings?	Analysis of Stats 19 data	1
Study 2: Public perceptions of existing crossings	What is the public perception of existing non-compliant zebra crossings?	User surveys of drivers and pedestrians at identified sites	2
Study 3: User recognition of alternatives to zebra markings	Are alternative markings as effective as zebra markings?	On screen reaction time study of responses to images with range of crossing markings	3
Study 4: Public perceptions of proposed crossing type	How do members of the public understand the meaning and purpose of non-prescribed side road zebras and how they should behave around them?	Online survey using simulated video and images	4
Study 5: Perceptions of proposed crossing type of people with disabilities	How do pedestrians with disabilities understand the proposed crossings and what are their perceptions of their safety and convenience?	Online survey, use of tactile model, interviews	5
Study 6: Driver simulator trials of proposed crossing	What is the effect of different pedestrian and vehicle flows on the propensity for vehicles to give way to	Driver simulator trial	6

Study name and number	Main research questions answered	Methods used	Tech. ann. #
	pedestrians on side roads with zebra markings?		
Study 7: On street trials of proposed crossing	How does the installation of a trial crossing affect the number and level of interactions between vehicles and pedestrians, and the willingness of drivers to give way?	Video observation of on-street trials at two sites, with and without non-prescribed zebra markings	7

The following section summarises the key findings for each of the research questions.

2 Overview of individual research questions

2.1 Study 1: Analysis of collision data from existing crossings

2.1.1 Summary of Methodology

Although the requirements for zig-zag markings would preclude positioning a fully compliant zebra crossing at the mouth of a side road crossing, examples of non-prescribed crossings can nonetheless be found across the UK, in particular on private roads such as in retail and industrial parks. Non-compliant designs range from being otherwise 'full' in that, apart from lacking the full zig-zag marking, they have all the other features of a zebra crossing, simple crossings that have only the striped markings ('non-full'). This provided an opportunity to investigate the injury collision record (vehicle occupants and pedestrians), using Stats-19 data, at existing sites and to compare 'full' and 'non-full' variations of the design.

The analysis considered two research questions:

- How does the collision record for 'full' zebra crossings at side roads compare with other nearby side roads with no markings?
- How does the collision record for 'non-full' zebra crossings at side roads compare with side roads with no markings?

A list of examples of side road crossings flush across the mouths of side roads was compiled through requests to transport practitioners across the country. Of these, 15 sites with 'full' zebra crossings and 38 with 'non-full' crossings were selected for analysis.

The baseline for the 'full' zebra crossings was a comparator site on a nearby side road with no pedestrian crossing facilities. Collision data was therefore collated for these locations too.

To provide a comparison dataset for the 'non-full' zebra crossings, collision data for general side roads with no pedestrian crossings across Great Britain was collated and the characteristics investigated.

Eight of the 'full' zebra crossings identified had an island or refuge in the middle of the crossing and seven did not, so collisions from 'full' zebra crossings with and without islands and their respective comparators were analysed separately.

STATS19 collision data was obtained for the period 2008 to 2017.

2.1.2 Findings

There were 57,661 injury collisions (vehicle occupant/rider and pedestrian) across all minor side roads with no pedestrian crossings in Great Britain between 2008 and 2017. Of these, there were 4,413 pedestrian casualties in urban side-road collisions. The vast majority (81%) of these casualties had severity recorded as 'slight', 18% were seriously injured and 1% were fatally injured. 93% of pedestrian casualties were in collisions involving only one vehicle. There were 3,886 vehicles involved in single-vehicle collisions with pedestrians. Analysis of the junction location and manoeuvre of these vehicles is presented in Figure 3.

Vehicles turning right (total of in and out of the side road) accounted for 53% of pedestrian casualties and turning left (in and out) accounted for 24%. The most common contributory factor reported was 'Driver failed to look properly'.

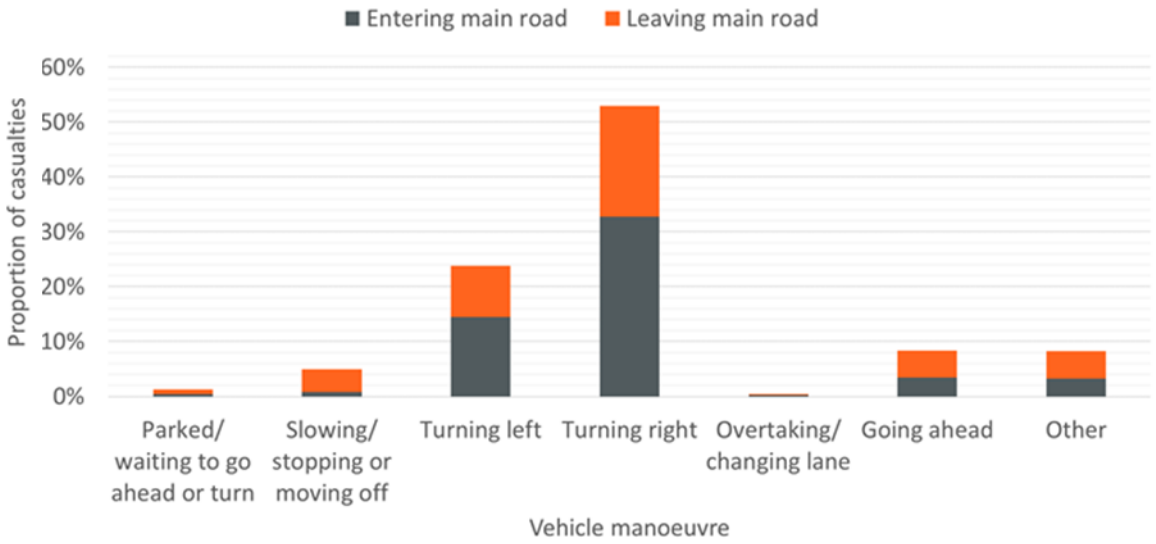


Figure 3: Proportion of casualties by manoeuvre and vehicle location at junction for single vehicle urban side road collisions involving pedestrians (total: 3,886)

In total, there were 16 collisions at 'full' zebra crossings with islands and 15 at comparator sites between 2008 and 2017 which occurred whilst the crossing in question was in place. There were 24 collisions at 'full' zebra crossings without islands and 23 at their respective comparator sites. Statistical tests showed that the differences between crossing types differences were not statistically significant.

Analysis of collision characteristics such as casualty class (pedestrian or vehicle occupant/rider), severity, vehicle manoeuvre and location and contributory factors showed little difference between the types of collisions which happened at 'full' zebra crossings both with and without islands and their comparators. However, the total numbers of collisions at the different locations were too small to perform statistical analysis on the distributions of individual collisions characteristics, because of the size of the sub-samples that would result.

The number of collisions at 'non-full' zebra crossings was much smaller than at 'full' zebra crossings: there were only 29 during the period of interest. This meant that the number of collisions at 'non-full' zebra crossing sites was too small to perform statistical tests comparing collision characteristics with side roads in general. However, the characteristics of collisions at general side roads and the specific locations with 'non-full' zebra crossings were generally similar.

The analysis found no evidence that the collision record at 'full' zebra crossings is different to the collision record at nearby side roads with no markings. Also, when comparing 'non-full' zebra crossings and side roads with no markings in general, there are no apparent differences

in any particular collision characteristic. However, it is important to note that all comparisons should be treated with caution as the numbers of collisions available for analysis is small.

Overall, there was no indication that the use of non-full zebra crossing would introduce significant additional risk in comparison to a full crossing.

Key findings

- No evidence was found that a side road crossing with 'non-full' zebra markings would introduce significant additional risks compared with a 'full' crossing.
- Vehicles turning right were found to pose a greater risk of collision with pedestrians than those turning left

2.2 Study 2: Public perceptions of existing crossings

2.2.1 Summary of Methodology

A shortlist of ten sites was selected from the sample of sites used in the collision analysis in Study 1. At these selected sites, roadside surveys were undertaken with pedestrians and drivers. The surveys were designed to investigate how the differences in design features between the "full" and "non-full" versions of non-prescribed zebra crossings would affect the perceptions and intended behaviour of road users.

Of the ten locations 7 were in London and 3 in Manchester. Five were 'full' crossings (zebra and zig-zag markings, beacons) and 5 'non full' (zebra markings only). Generally, they were placed flush with the mouth of a side road or aligned with the footpath (see Figure 4). The survey captured 121 participants at full zebras (29 drivers and 92 pedestrians) and 109 at non-full zebras (24 drivers and 85 pedestrians).

Full zebras: four sites in London (1M, 1K, 1I, 1G) and one in Manchester (2A)

Non-full zebras: three sites in Manchester (E18, E23) and three sites in London (E39,E17,E86)

Figure 4: Sites used for surveys

Survey questions asked participants about how often they used the crossing, their perceptions of safety, how visible they found it (drivers), who they thought had priority and, for pedestrian participants, their perceived convenience of the crossing and how likely they would be to cross the road without using the crossing.

2.2.2 Findings

Drivers and pedestrians were both asked to rate how safe they felt using the crossings. Responses for both samples were mixed – with some reporting they felt safe and others unsafe – and there was no statistically significant difference between crossing types.

The reasons given for feeling unsafe were similar across the crossing types:

- Both drivers and pedestrians commented that the position of the crossing obstructed the view of drivers.
- Pedestrians commented that car drivers generally do not stop when confronted with the crossing or drive too fast across it.
- Drivers suggested that they had difficulty turning into the road and exiting due to the proximity of the crossing to the main road.

In contrast, some pedestrians commented on feeling safe because of the presence of other pedestrians on the crossing (full zebra) or because of a lack of traffic on the road (non-full zebra).

Drivers were asked to comment on their understanding of how the crossing should be used, in particular who has priority (Figure 5). For the full zebra crossing, almost two thirds of participants (19 out of 29) reported that pedestrians on the crossing have priority; whilst for the non-full zebra crossing this figure was smaller (8 out of 24); however more people stated that pedestrians approaching the crossing have priority (11 out of 24). The sample sizes in the groups were too small for robust statistical tests on this measure.

When drivers were asked about visibility of the crossings, responses were mixed with a similar number of drivers reporting it was difficult to identify the crossing as those reporting it was easy to see the crossing. There was no significant difference between the two crossing types.

Pedestrians were asked about the convenience of the crossings. Over three quarters of participants (78 out of 92) reported that the full zebra crossings were 'convenient' or 'very convenient', but this figure was lower (just over half, 49 out of 85) for the non-full crossings. The difference was statistically significant.

Consistent with these findings, while 61% of pedestrians reported that they were unlikely to cross the road without using the crossing at sites with full zebras, 35% gave this response at sites with non-full zebras. However, it is important to note that the full zebras were more commonly situated in line with the pedestrian path. Comments provided by respondents suggested that the perceived convenience of using the zebras was impacted by both perceptions of safety and by being able to continue along a walking route across the mouth of the side road in a straight line.

Pedestrians were also asked to comment on their understanding of how the crossing should be used, in particular who has priority (Figure 6). For both crossing types around half of participants reported that a pedestrian on the crossing had priority (46 out of 92 for full zebra and 40 out of 85 for non-full zebra). Pedestrians approaching the crossing was also a popular choice (44 out of 92 for full zebra and 32 out of 85 for non-full zebra). However, overall the responses were more mixed for the non-full zebra with 13 respondents saying vehicles (motor vehicles or large vehicles) had priority, compared to just two for the full zebra. The differences were statistically significant.

It is important to note that the results may be affected by the different contexts tested. The full zebras which were in line with the mouth of junctions were mainly in busier areas, whereas the non-full zebra crossings were located in quieter streets.

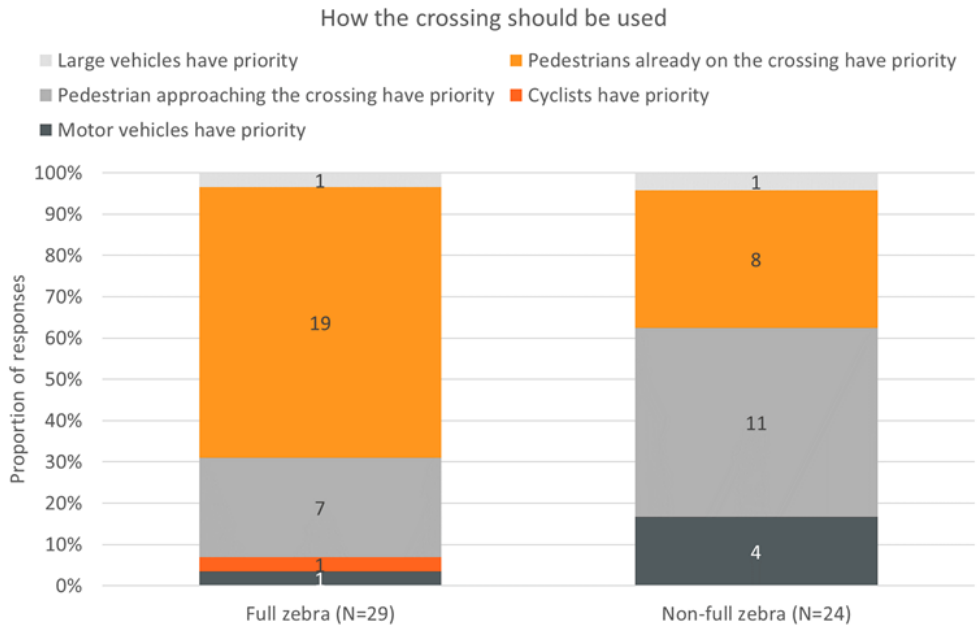


Figure 5: Who has priority- driver responses

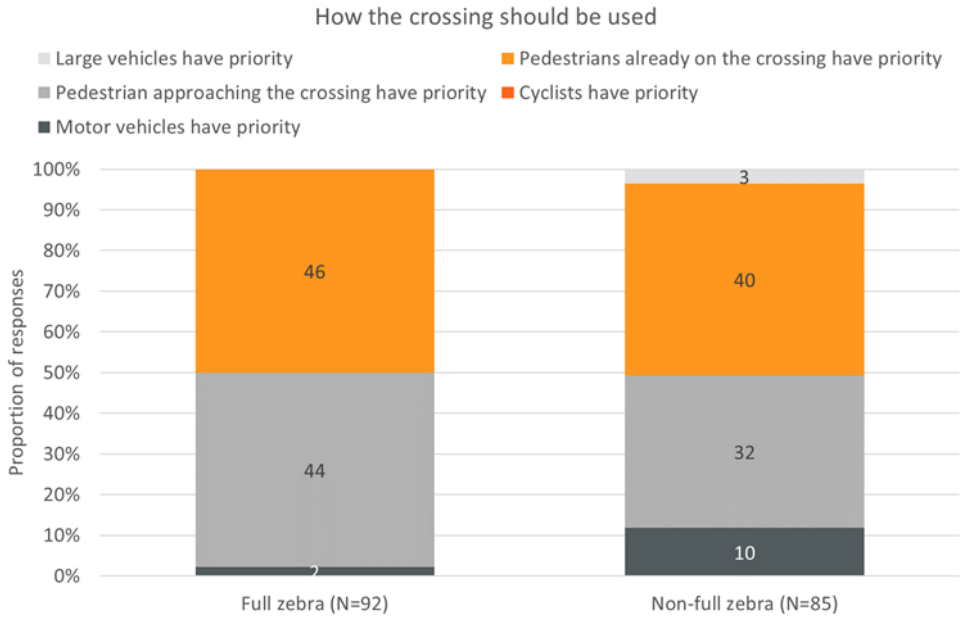


Figure 6: Who has priority: pedestrian responses

Both pedestrians and drivers indicated that they would make changes to the design of the crossings for both the full and non-full zebras. These included enhancing the visibility of both full and non-full zebras through improved lighting and moving the zebras further down the street, therefore bringing them more in line with the design of prescribed zebras. However, it should be noted that within the scope of this study, the tendency of participants to want to make changes to a crossing was not measured in comparison with either prescribed zebra crossings or side-roads with no crossings and it is therefore not clear if similar issues would have been raised.

In conclusion, this study found that the design features which differed between the two crossing types (namely, Belisha beacons, stripes and studs) did not have a significant impact on how pedestrians and drivers perceived crossing them in terms of their safety and visibility. Most significantly, a majority of drivers consider that pedestrians have priority with both crossing types.

Key findings

- There was no significant difference in drivers' subjective ratings of visibility between the crossing types
- Overall, a majority of drivers believed pedestrians had priority over vehicles when using both crossing types.
- Pedestrians' ratings suggested that full zebra crossings were more convenient to use than non-full crossings.
- Pedestrians were less likely to cross the road without using the crossings at sites with full zebras compared with sites with non-full zebras.

2.3 Study 3: User recognition of alternatives to zebra markings

2.3.1 Summary of Methodology

The purpose of this study was to investigate several alternative non-prescribed pedestrian crossing designs, alongside a non-prescribed zebra, to determine the design that is quickest and easiest to correctly identify and understand by pedestrians and drivers. Six alternative crossing designs were tested (see Figure 7).

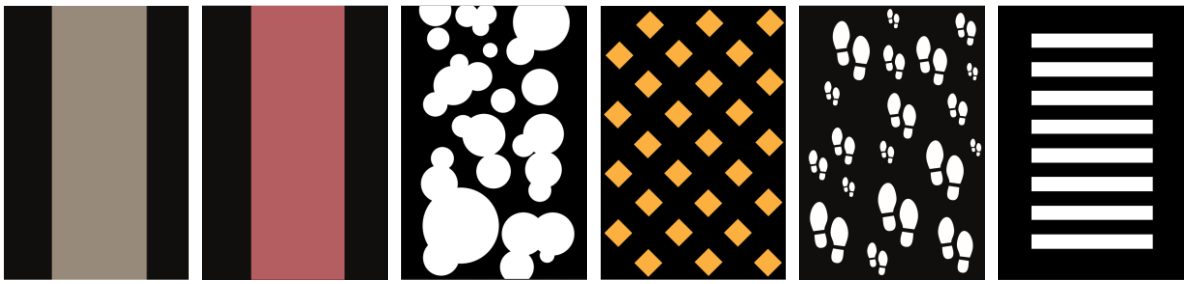


Figure 7: Alternative crossing designs included in the study

The study consisted of a response time trial and a post-trial questionnaire conducted in a controlled laboratory environment. Participants were presented with stimuli where each crossing design (plus a control which showed no crossing) was superimposed onto photographs of real-world side-road junctions, taken from the perspective of a driver and a pedestrian. The images were shown on a computer screen for 3 seconds, after which participants were asked whether they noticed a dedicated point at which a pedestrian can cross. The trial measured whether participants noticed a crossing in the road scene, and the

speed (response time) at which they made the decision. Following the response time test, participants completed a post-trial questionnaire to gather data about their understanding, confidence, and perceived safety of the crossing designs. A total of 90 participants were recruited for the trial through TRL's Participant Database.

2.3.2 Findings

The results showed that the non-prescribed zebra crossing performed best on all measures. Participants were significantly more likely to identify a crossing with a non-prescribed zebra than one with any of the alternate types of crossings (see Figure 8).

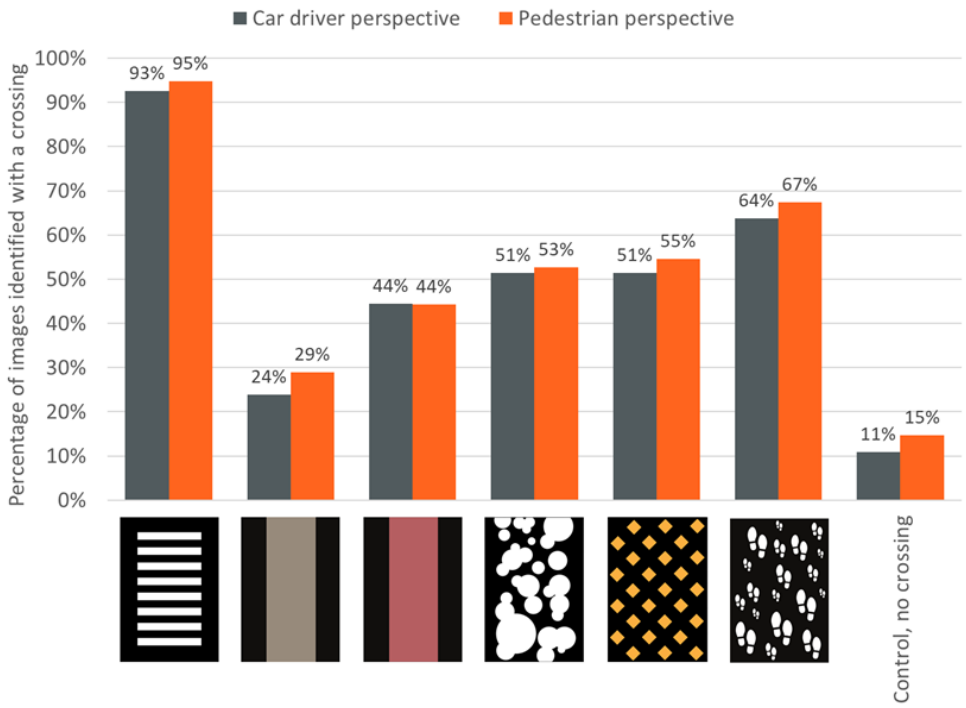


Figure 8: Percentage of images in which the participant identified a crossing, by crossing type and side road location

Respondents also reported feeling more confident and safer when imagining using the non-prescribed zebra crossing relative to the alternative designs (see Figure 9). Many participants stated in open ended questions that they were familiar with the zebra crossing and felt safe as a result, and that it was a universally understood design.

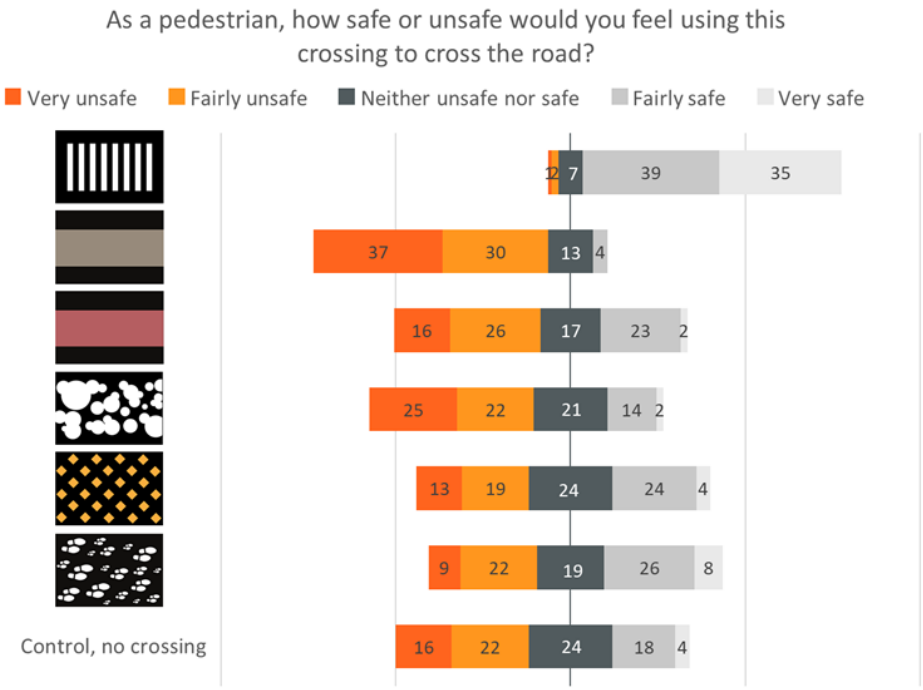


Figure 9: Reported feeling of safety by crossing type

Of the alternative designs, the footprints performed the best as this was identified as a crossing in almost two thirds of stimuli and the reported confidence and safety were the highest of all the alternative crossings. The buff-coloured crossing was the least preferred and performed worse on the confidence and perceived safety measures than no crossing (the control condition).

Based on the results, the study recommended to pursue the on-street trials with the non-prescribed zebra crossing. In addition, the footprint design was also taken forward to the simulator study for further comparison with the non-prescribed zebra markings.

Key findings

- Zebra markings performed significantly better than all the alternatives in terms of measures related to crossing recognition and perceived safety
- Of the alternative markings, the footprints performed the best in terms of crossing recognition and perceived safety

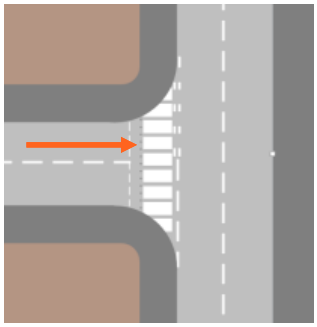
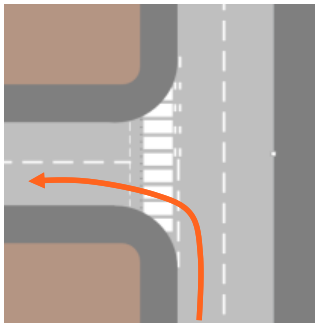
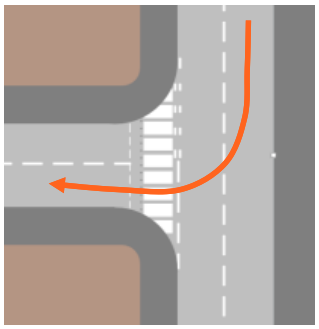
2.4 Study 4: Public perceptions of proposed crossing type

2.4.1 Summary of Methodology

An online questionnaire was used to collect information about the public perceptions around safety and priority when using a non-prescribed zebra crossing in comparison to having no crossing. The questionnaire had two distinct sections, with respondents answering questions either from the driver's or the pedestrian's perspective. The driver version used simulated videos and the pedestrian version used still images to show various pedestrian crossing scenarios at a junction where a side road meets a main road. Each scenario differed based on

the crossing type (non-prescribed zebra crossing or no crossing), direction of pedestrian movement (left to right, right to left, or both – see Table 3) and direction of vehicle movement (into side road from the left, into side road from the right or out of the side road). After each visual stimulus (video or image) respondents were asked about their perceptions of priority and safety and their anticipated behaviour through quantitative (single/multiple choice), and qualitative (open-ended) questions.

Table 3: Turning movements

1. Out of side road	2. Into side road (left)	3. Into side road (right)
		
The car approaches the junction from the side road and stops before the crossing.	The car begins to make a left-hand turn from the main road into the side road.	The car begins to make a right-hand turn from the main road into the side road.

Participant recruitment was via TRL's Participant Database and TRL's and TfGM's Twitter sites. Eligible participants (over 18 years old) were incentivised by being entered into a prize draw to win £200. In total, 111 participants completed the driver questionnaire and 66 completed the pedestrian questionnaire.

2.4.2 Findings

2.4.2.1 From the driver perspective

Most drivers correctly identified the presence of a crossing when presented with videos showing a non-prescribed zebra crossing. However, the non-prescribed zebra crossing was significantly easier to identify from the perspective of a driver turning out of the side-road than from the perspective of turning into it. The crossing was most difficult to identify from the perspective of making a right-hand turn into the side road.

Regarding interaction with pedestrians, significantly more drivers reported that they would slow down / stop and look for pedestrians waiting on the pavement or starting to cross when a non-prescribed zebra crossing was present in the image than when shown an image without a crossing. Willingness to give way was affected by the direction of turning, with the highest reported intention to give way observed for images view from the perspective of turning out of the side road (see Figure 10)

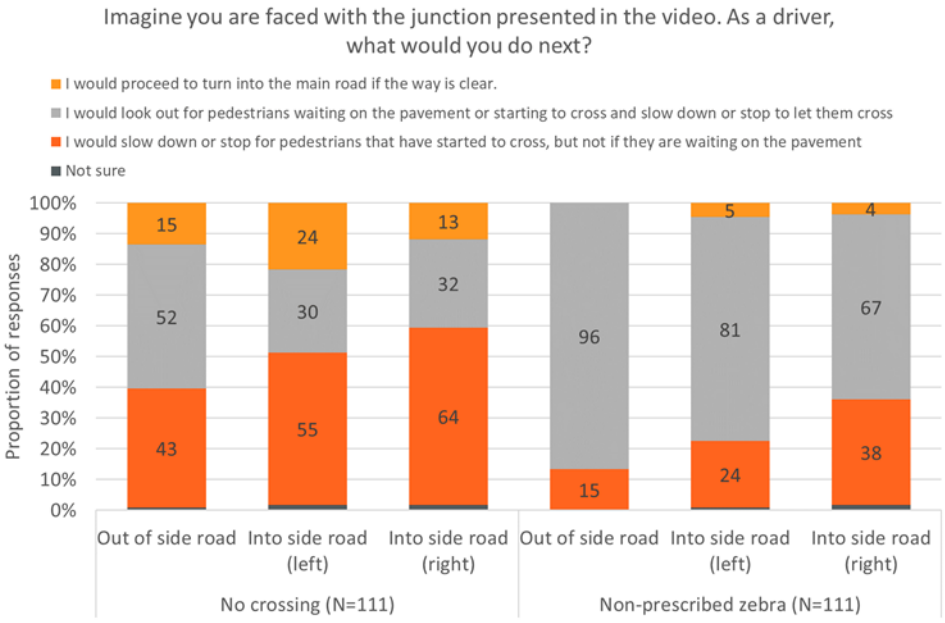


Figure 10: Reported driver action when presented with each junction scenario

In free-text responses driver participants stated that the presence of a crossing increased their awareness of pedestrians, signalling that pedestrians would likely to be crossing in the area and they would have the right of way. Safety concerns were raised by some drivers over the need to stop before turning into the side road and reported lower willingness to give way when being followed by other vehicles in these scenarios. Several participants commented that without a designated zebra crossing, the driver has priority on the road, but they would still stop to give way to pedestrians if they had already started crossing the road.

The change in willingness to give way was observed for all turning movements. However, in situations where the vehicle was making a turn into the side road fewer drivers reported that they would slow down or stop for pedestrians who are waiting on the footway but have not started crossing, in comparison with other turning movements. This was true for both the non-prescribed zebra crossing and the no crossing conditions, indicating that when drivers are turning into side-road they may have concerns with slowing down/stopping on the opposite lane of the main road to allow pedestrians to cross.

Drivers had more safety concerns about junctions with a non-prescribed zebra crossing than those without a crossing. Safety concerns were highest when viewing from the perspective of making a right-hand turn into the side road; 60% of the driver sample reported that the non-prescribed zebra crossing was unsafe in this scenario, compared to 30% for junctions where there was no crossing. When drivers were asked to provide suggestions for improving the layout of non-prescribed zebra crossings, the most common suggestions were moving the crossing further away from the junction and adding signage; modifications which would bring the crossing design more in line with a prescribed zebra crossing in a mid-link location. However, this would not provide pedestrians with the direct crossing route on their desire line that is the purpose of the proposed crossing.

2.4.2.2 *From the pedestrian perspective*

The presence of a non-prescribed zebra crossing affected the way pedestrians said they would behave at the junction, with a large increase in people saying they would expect drivers to give way to pedestrians (see Figure 11). A small proportion of participants chose the option to look for somewhere else to cross: between 3 and 6 participants (4% - 9%) for no crossing and with only 1 or 2 participants with the non-prescribed crossing.

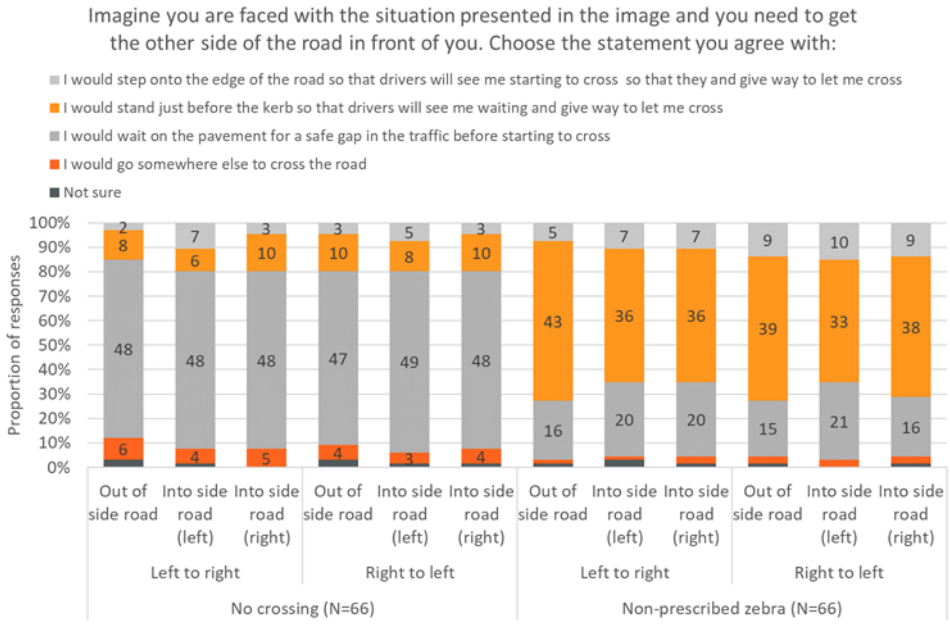


Figure 11: Reported pedestrian action when presented with each junction scenario

More than half of participants reported that they felt the non-prescribed zebra crossing was safe and they would be more likely to cross than in situations where no crossing is present. In general, pedestrians felt safer when shown a junction with a non-prescribed zebra crossing compared to a junction with no crossing. Respondents remarked in free- text comments that the increased perceptions of safety were because the zebra crossing serves to alert drivers of the presence of pedestrians wishing to cross. However, concerns were raised that drivers would not expect a crossing in that location and that there may be issues at busy locations. Over half of the pedestrian sample recommended making changes to the layout of the non-prescribed zebra crossing, including moving the crossing further away from the junction and adding warning signs; however a much smaller proportion had indicated that they would cross elsewhere themselves, so relocating the crossing would not necessarily result in increased use.

Key findings

- Driver willingness to give way was greater with the non-prescribed crossing.
- Willingness was affected by the direction of turning, with highest intention to give way reported when viewing images from the perspective of a driver turning out of the side road
- Non-prescribed zebra crossings were significantly easier to identify when shown from the perspective of drivers turning out of the side-road than turning into it.
- Drivers had more safety concerns about junctions with a non-prescribed zebra crossing than those without a crossing. Safety concerns were highest when viewed from the perspective of drivers making right-hand turns into the side road.
- Pedestrians felt safer when shown a junction with a non-prescribed zebra crossing compared to a junction with no crossing.

2.5 Study 5: Perceptions of proposed crossing type by users with disabilities

2.5.1 Summary of Methodology

Study 5 investigated perceived safety and ease of use of non-prescribed zebra crossings, in comparison to no crossing, from the perspective of people with disabilities. The views of five disability groups were examined: (1) mobility impaired, (2) deaf and hearing impaired, (3) blind and visually impaired, (4) learning disability and cognitive disorder, and (5) mental health conditions. The type and number of respondents as well as the data collection method for each disability group are summarised in Table 4.

Table 4: Summary of respondents and data collection

Disability group	Type of respondents	Data collection method	No. of respondents
Mobility impaired (including wheelchair users)	Individuals with mobility impairments recruited from TRL's participant database	Online survey	24
Deaf and hearing impaired	Deaf individuals or individuals with hearing impairments recruited through groups on social media	Online survey	17
Blind and visually impaired	Blind individuals or individuals with visual impairments recruited through groups on social media	Telephone interviews with 3D tactile model sent by post	4
Learning disabilities and cognitive disorder	Representatives of organisations representing people with learning disabilities	Online interviews conducted on Microsoft Teams	4
Mental health conditions	Representatives of organisations representing people with mental health disabilities	Online interviews conducted on Microsoft Teams	4

Respondents were asked to imagine they encountered a junction with a non-prescribed crossing and determine their likelihood and ease of using it and their perceived safety around the crossing. The crossing was explained using images for all groups except the blind and visually impaired group, who were sent 3D tactile models in the post prior to their interview (see Figure 12 for an example of the model).

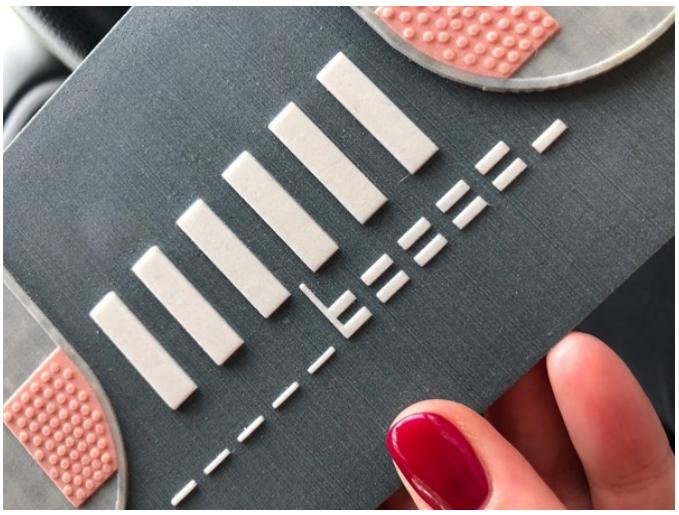


Figure 12: 3D Tactile model of non-prescribed zebra crossing sent to blind or visually impaired participants (with finger reference showing scale)

2.5.2 Findings

Most respondents with a **mobility impairment** (15 out of 24) said that they would likely use a non-prescribed zebra crossing and that it seemed convenient to use. Generally, participants responded positively about the effect of the proposed crossing. Nine out of 24 respondents said it was better than not having any crossing, or that the markings were a good reminder for drivers to slow down, or that a shorter walking distance would make their trip easier. Those who said they would be less likely to use the crossing or found it inconvenient expressed concerns about not being seen by drivers, specifically referring to the lack of traditional zebra crossing features (such as the Belisha beacons) which would indicate to drivers to look out for pedestrians. In addition, the position of the crossing close to the mouth of the road raised some concerns. Some participants felt that a vehicle would not have enough time to stop for a pedestrian. Participants' feelings of safety varied with the type and turning movement of the vehicle, with the lowest perceived safety associated with large vehicles turning into the side road. The two most common suggestions from participants for improving the junction layout were adding warning signs or road markings and moving the crossing away from the junction.

Respondents from the **hearing-impaired** group were split when asked how likely they would be to use the crossing. Seven were ‘highly unlikely’ or ‘unlikely’ to use these crossings; whilst eight were ‘likely’ or ‘highly likely’. While there were participants who welcomed the position of the crossing, as they felt it would make their journey easier, some of them expressed safety

concerns and uncertainty about priority. Similar to the mobility impaired group, they felt that drivers may not be aware of the crossing and may not see pedestrians and stop in time. This was the main safety concern among this participant group as their ability to hear oncoming traffic from behind them is impaired. Participants' feelings of safety were lowest in respect of large vehicles turning into the side road. Participants were concerned about not being seen by the driver of large vehicles as they have a higher seating position. The top three suggestions from participants were to move the crossing away from the junction, add warning signs for drivers, and to improve visibility of the crossing to drivers. This would of course be equivalent to using an existing type of crossing that is already permitted mid-link.

While three of the four participants who were **blind or visually impaired** said they would be 'very likely' to use the crossing, there were concerns about its proximity to the main road. In particular, the perceived risk that pedestrians who were blind or partially sighted could accidentally walk out into a lane on the main carriageway if they deviated from the crossing line. They highlighted the importance of installing tactile paving correctly to ensure that pedestrians were directed across the crossing point accurately and safely. Another factor that was raised was that the volume, speed, and noise of traffic has a huge impact on the ability of blind people to detect when it is safe to cross. It is therefore essential that traffic speed, density, and noise at the junction should be considered when selecting appropriate sites. These factors impact whether a blind or partially sighted pedestrian would use this crossing point or whether they would "*indent*" further into the side road before attempting to cross. Sites with high traffic speeds or flows, or high levels of traffic noise, should be avoided, especially where there may be significant numbers of users with disability and no alternative crossing route is available nearby.

Health care professionals and carers were interviewed on behalf of people with **learning disabilities, cognitive disorders, and mental health conditions**. Most participants across these groups felt that people with learning disabilities, cognitive disorders and mental health conditions will tend to interact with the new crossing design as if it was a prescribed zebra crossing because it is recognisable, and the patterns are familiar. Further, the simplicity of the design meant that most people will not be distracted or confused by having to complete additional tasks before crossing. Participants also welcomed having the crossing in the direction of the desired walk line. For people with cognitive disorders that have lost some visual processing capacity, the provision of a single-coloured path across the junction could support crossing behaviour.

Most participants reported that infrastructure changes have an impact on the ability of people with disabilities to navigate their environment. Information and communication were therefore raised as key components to the successful introduction of the new crossing design. The position of the crossing close to the mouth of the road also raised some safety concerns. These included that pedestrians would need to look behind them to check if a vehicle is about to turn into the sideroad and then be able to correctly interpret the behaviour of the vehicle as turning, instead of just looking left and right before using the pedestrian crossing. The visibility of the crossing for drivers and other road users were also a concern. Some of the suggestions participants made included moving the crossing away from the junction, slowing vehicles down on the main road or adding vehicle stopping restrictions across the junction. Several participants felt that it would be important to introduce the new designs only after the impact of other factors such as the traffic density and speed in the main road have been considered.

Key findings

- The convenience and simplicity of new non-prescribed zebra designed was welcomed by many of the disability groups.
- There was general concern about the proximity to the main road and lack of time for drivers to stop. Concerns were highest for situations when vehicles are turning into the side road and for large vehicles.
- Key suggestions include conveying clear information about the new crossing, slowing down vehicles and conducting further testing considering traffic density and speed.

2.6 Study 6: Driver simulator trials of proposed crossing

2.6.1 Summary of Methodology

The purpose of this study was to explore the propensity of drivers to give way to pedestrians at different crossing types with different levels of pedestrian flow. To understand the impact of the crossing types and pedestrian flow, two research questions were set. The first question looked to understand the impact of the crossing type, independent of pedestrian flow. The second research question concerned the impact of pedestrian flow along with the crossing type.

DigiCar, TRL's full scale driving simulator (see Figure 13), was utilised to test two non-prescribed crossing designs, a zebra design and a 'footprints' design, along with a conventional junction with no pedestrian crossing to serve as a control. The designs were implemented on a representative side road in a simulated urban environment.

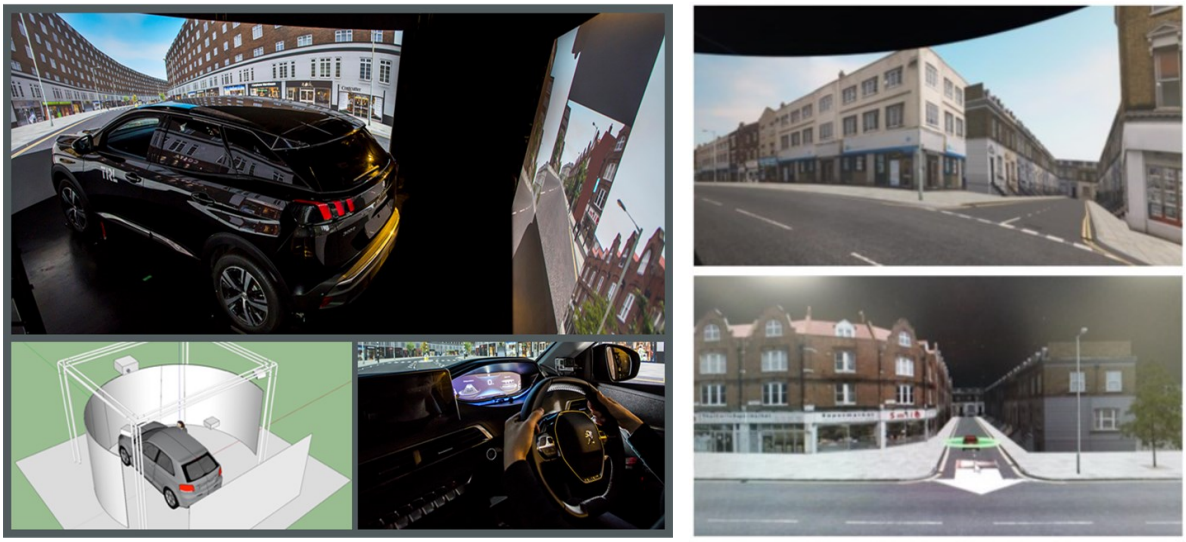


Figure 13: TRL's DigiCar driving simulator and crossing

A combination of four vehicle movements, two pedestrian flow levels and three crossing types created a total of 24 different conditions which were tested in the DigiCar simulator (see Table 5). Each condition was tested in a separate drive in the simulator. All scenarios included a vehicle following behind the participant's vehicle; and high flow traffic on the main road for both right-turn movements. A repeated measures study design was employed, whereby all participants experienced all 24 conditions. A post-trial questionnaire (PTQ) was administered to participants, made up of quantitative, multiple choice questions as well as qualitative, open-ended questions, that focused on examining how easy or difficult the participants found it to give way to pedestrians crossing the road. Forty participants were recruited to take part in the trial through TRL's Participant Database and social media channels.

Table 5: Variables investigated in the driving simulator study

Variable	Levels	No. of levels
Crossing type	Footprints Non-prescribed zebra No crossing (control)	3
Vehicle movement	Left turn into side road Right turn into side road Left turn out of side road Right turn out of side road	4
Pedestrian flow	High Low	2
Total number of conditions		24

2.6.2 Findings

Responses to the PTQ provided insights into participants' preferences and understanding in relation to give way behaviour, identification of a crossing, and recognition. Results indicated that participants found it easiest to decide whether to give way when the crossing was a non-prescribed zebra crossing and most difficult when there was a footprint crossing. In terms of identifying the two different designs as a pedestrian crossing, when approaching from both the main road and the side road participants found the footprints crossing to be more difficult to identify compared to the zebra crossing. All participants recognised the non-prescribed zebra design as a pedestrian crossing.

Analysis of the DigiCar driving data showed that a non-prescribed zebra is likely to be more effective than no crossing in getting drivers to give way to pedestrians at side roads; however, drivers turning right into the side road were less likely to give way than those turning out. Pedestrian flow levels did not have a significant impact on driver behaviour.

Key findings

- **A non-prescribed zebra is likely to be more effective than no crossing in getting drivers to allow pedestrians to cross at side roads.**
- **Pedestrian flow levels did not have a significant impact on driver behaviour.**
- **Willingness to give way was greater with the non-prescribed zebra crossing than the alternative 'footprints' markings.**

2.7 Study 7: On-street trials of proposed crossing

2.7.1 Summary of Methodology

The research programme concluded with monitoring of on-street trials at two sites in Greater Manchester. Because the non-prescribed crossing is not currently approved by DfT, and the trials were not covered by an experimental traffic order, TfGM undertook a comprehensive risk assessment before proceeding with the trials[2]. Two sites were selected by TfGM, representing different examples of low-risk environments where such crossings might be used in an initial roll-out. Video observations were made with and without the zebra markings in place. The two sites, with and without their markings are shown in Table 6. At both sites snapshot counts were undertaken by TfGM staff to estimate the likely number of crossing interactions that would be observed. Although pedestrian numbers were higher at Peel St, in both cases traffic flows were sufficiently low that the majority of pedestrians observed were able to cross without any interaction with a vehicle.

[2] Non-prescribed zebra crossings at side roads: legal advice. Deegan B and Huxford R, report by Urban Movement for TfGM, 2021

Table 6: Summary of trial sites

Site	Peel St/Manchester Rd (A57)	Hazelwood Dr/Ravenwood Dr
Description	High street, with busy traffic, high pedestrian flow, shops, and other amenities	Residential area, with low levels of vehicle and pedestrian flow
Without markings		
With markings		

The study was designed to answer two research questions:

- What level of interaction is present before and after application of side road zebra markings?
- Is the propensity for motor traffic to give way to pedestrians increased when the zebra markings are applied?

In this context an 'interaction' was defined as some form of interplay between motorists and pedestrians. This varies from road users simply wanting to use the same piece of road space at the same time but following the rules without any conflict (including giving way), through to harsh braking, near avoidance, and collision itself. Understanding interaction is important for two reasons:

- The higher-level interactions, i.e., those indicating conflict, can point towards a likelihood of actual collision.
- More serious interactions are likely to discourage pedestrians from walking as they may make them feel uncomfortable and at risk.

In line with previous on-street studies of road user conflicts, TRL utilised a five-point scale of interaction ranging from (1) 'precaution' through (2) controlled action, (3) near miss, (4) very near miss to (5) collision.

It is important to note that for a crossing of this type, where one party is expected to give way to another, the desired behaviour will be included in the count of interactions, predominately at level 1 but potentially also within 2. That is, a pedestrian giving way to a vehicle with no markings present would count as an interaction, as would a vehicle giving way to a pedestrian with the markings present, so a change in propensity to give way would not directly affect the

number of interactions observed. The focus was therefore on the severity of the interaction, rather than the number, for the same number of crossing events observed.

Experience from previous studies was that a target sample of around 200 interactions between pedestrians and vehicles at each site in each phase would be needed to achieve a sufficient sample for statistically significant analysis of changes in behaviour. To align with hours of most pedestrian activity and hours of daylight it was planned that the first 2 interactions seen from the start of each of 14 hours (starting at 7am, with the final observations starting at 8pm) would be collected. To assess the likelihood of reaching a sufficient sample at each site casual observations of user numbers and crossing movements were undertaken by the client. On the basis of this sample, it was agreed that video observations would be recorded for 2 weeks in each phase to attempt to reach a sample of 196 interactions.

The video data were extracted by trained enumerators onto a spreadsheet table to record standardised observations on each crossing movement, including the number of road users present, the direction of movement of each, where the pedestrian crossed, who gave way and an assessment of the conflict level (using the five-point scale described above).

Video recordings were made between May and July 2021, including time between recordings during which road markings were adjusted between the two crossing types.

2.7.2 Findings

The target of 196 observations (both with and without the non-prescribed zebra crossing) was reached at Peel St; however, at Hazelwood Drive a much smaller sample was achieved: 38 'with' the markings and 35 'without'. Traffic flows were very low at the latter site and potentially still affected by Covid-19 restrictions in force during that period. Nonetheless, some statistically significant conclusions were drawn for both sites.

The total number of interactions by severity level is shown in Figure 14 for both sites, comparing with and without the zebra markings. The vast majority of interactions were Level 1 ("precaution") at both sites, with and without the markings. This reflects people crossing the road with one party giving way to another without conflict. A much smaller number of level 2 interactions ("controlled action") was observed, with very small changes between level 1 and level 2 which were not statistically significant (using a chi-squared test). A single level 3 conflict ("near miss") was observed at one site- this does not represent a statistically significant change in conflict level.

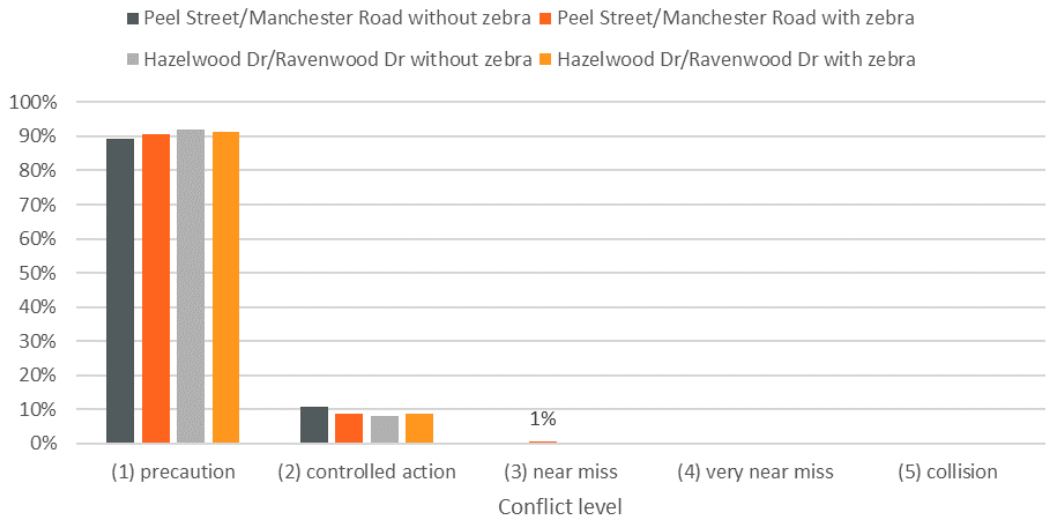


Figure 14: Comparison of interaction numbers and levels at both sites

When an interaction occurred, a record was made of whether the pedestrian or vehicle gave way. Giving way was defined as one party stopping or slowing to allow another party to pass in front of them, where a conflict would otherwise occur. The proportion of vehicles that gave way to pedestrians is shown in Figure 15 (Peel St) and Figure 16 (Hazelwood Drive).

- The propensity of vehicles to give way increased at each site, from 43% 'without' to 71% 'with' at Peel St and 26% 'without' to 57% 'with' at Hazelwood Drive.
- The chi-squared test confirmed that the increased propensity to give way has a statistically significant association with the introduction of the non-prescribed crossing. The relationship was particularly evident for the Peel Street/Manchester Road location.

It can therefore be concluded that give-way behaviour was improved by the introduction of the non-prescribed zebra crossing, with a majority giving way following its introduction, and that this improvement was statistically significant.

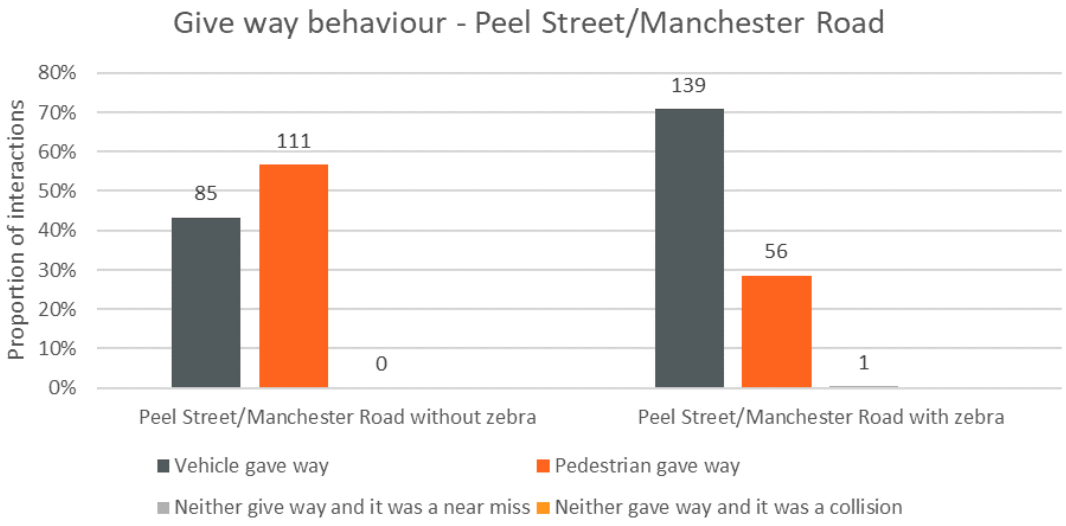


Figure 15: Propensity to give way: Peel St

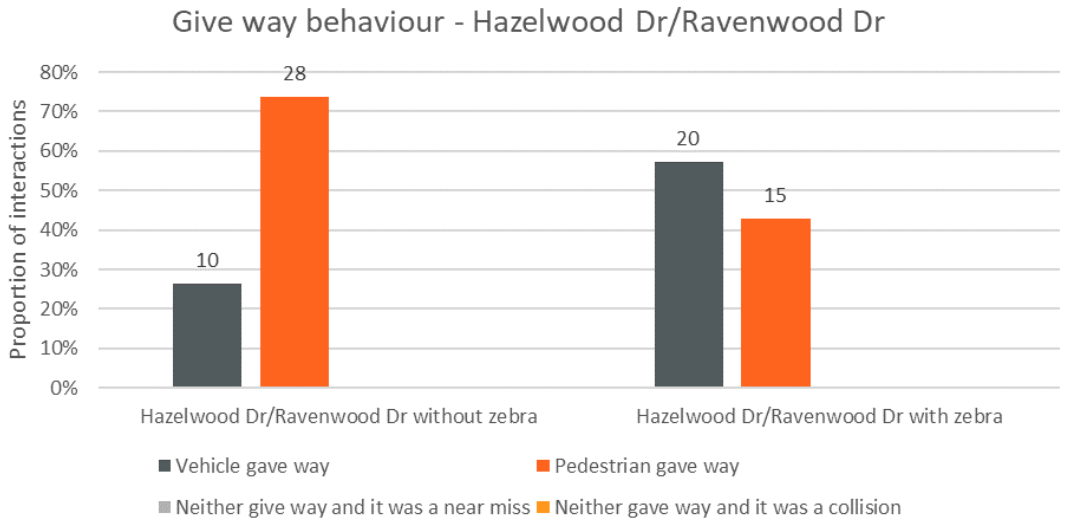


Figure 16: Propensity to give way- Hazelwood Drive

As reported in earlier sections, evidence from previous user studies in the programme, in particular the driver simulator study (Study 7), have indicated that drivers might be less likely to give way when turning into the junction than when turning out. Observations from the on-street trial were classified by turning movement, as shown in Table 4. The results show that drivers were more likely to give way whilst turning from the side road (shown in orange) than when turning into it (shown in blue), both with- and without- the non-prescribed zebra crossing. Overall, 71% of drivers gave way at Peel St with the crossing; however, for right turns into the side road this was 49%, whereas 92% gave way when turning right out of the side road.

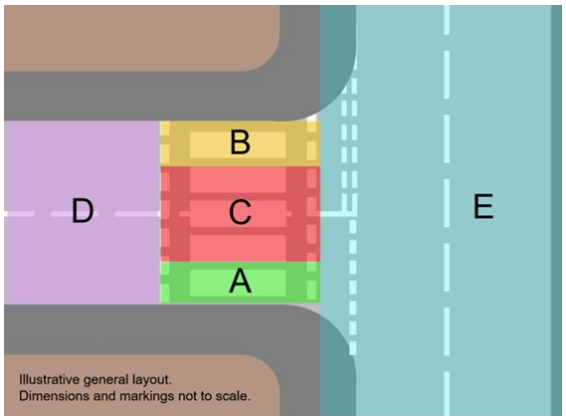
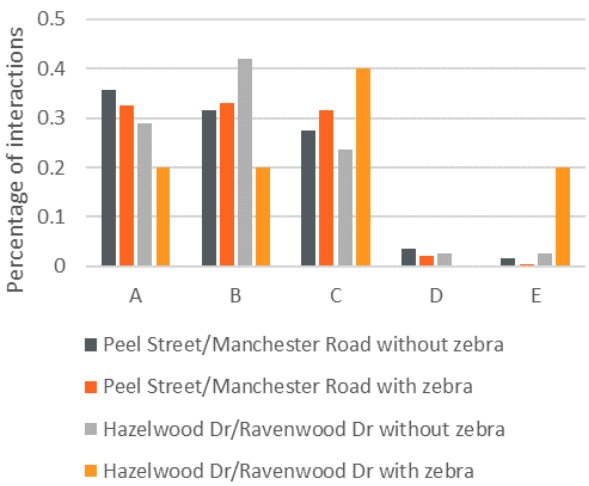
Note that because this involves further subdivision of the sample with some small counts in some of the sub-groups, statistical analysis was not possible.

Table 7: Give way behaviour by turning direction

Movement	Measure	Peel Street without zebra	Peel Street/ with zebra	Hazelwood Dr without zebra	Hazelwood Dr with zebra
1. Left turn from side road on to main road	Sample	63	66	7	3
	Number giving way	33	53	1	2
	% giving way	52%	80%	14%	67%
2. Right turn from side road on to main road	Sample	41	38	3	4
	Number giving way	22	35	1	3
	% giving way	54%	92%	33%	75%
3. Left turn from main road in to side road	Sample	45	41	11	12
	Number giving way	17	26	6	6
	% giving way	38%	63%	55%	50%
4. Right turn from main road to side road	Sample	47	51	17	16
	Number giving way	13	25	2	9
	% giving way	28%	49%	12%	56%

Analysis was also undertaken of where pedestrians cross, according to zones as defined in Table 8.

Table 8: Crossing observations by zone

Zones used for recording crossing location	Interaction by location around crossing
	

Analysis of the crossing movements observed found that the majority of interactions occurred within the non-prescribed zebra crossing area itself (Locations A, B, and C). At Hazelwood

Drive there was a higher incidence of crossing movements within Location E, across the mouth of the junction (observations were between the give-way markings for the zebra crossing and the give way markings for the main carriageway) rather than on the marked crossing, as shown in Table 8. At Hazelwood Drive the non-prescribed crossing was set further back down the side road than at Peel St; this is an indication that in practice pedestrians prefer the most direct crossing line, which is a benefit of providing formal crossings at the mouths of side-roads.

Key findings

- Drivers' propensity to give-way improved at both sites, from 43% 'without' to 71% 'with' at Peel St and 26% 'without' to 57% 'with' at Hazelwood Drive.
- There was no statistically significant change in the level of conflict observed following the introduction of the non-prescribed crossing.
- Giving way was significantly lower for vehicles turning right into the side-road than for those turning out.

3 Discussion of research conclusions

As explained in Section 1, the research programme was designed to follow a sequence, beginning with desktop studies of the risk of existing sites, progressing through user research, and culminating in on-street trials. Earlier stages therefore informed later stages and helped to manage risk. When comparing the findings from the different studies, several common themes can be identified.

Table 9 summarises the main findings from the research programme and maps them against the studies that support them. While the greatest weight should be attached to findings from the later stages, and in particular the on-road trials, it is helpful when this is supported by earlier studies thereby providing evidence that the trial findings can be generalised beyond the specific sites where the trials were undertaken. The main conclusions from the research programme are summarised as follows.

The non-prescribed crossing improves drivers' propensity to give way but does not increase the level of conflict between road users. Pedestrians are more likely to cross where a non-prescribed zebra crossing is provided. Compliance with the non-prescribed zebra is worse for drivers turning into the side road than turning out and this is likely to worsen when vehicles are following.

Investigation of existing non-prescribed zebra crossings found no evidence that using a simplified crossing with only the zebra markings would have significantly greater risk than using the full range of prescribed zebra crossing features. A comparison between zebra markings and a range of possible alternative patterns concluded that zebra markings were most easily recognised.

Qualitative feedback from user surveys, in particular interviews with the disability groups, has identified a number of areas where user concerns may need to be mitigated through site selection, design details and potentially, awareness raising and training.

The overall conclusion is that there is strong evidence that non-prescribed zebra crossings at side roads can lead to greater convenience for pedestrians, and improved compliance by drivers without introducing significantly greater risk. Further trials will enable this to be tested at a wider range of sites and traffic conditions.

Table 9: Main findings of the research programme

Supporting studies	Details
Finding: The non-prescribed crossing does not increase the level of conflict between road users	
(7) On street trials	There was no statistically significant change in the level of conflict in interactions following the introduction of the non-prescribed crossing
Finding: The non-prescribed crossing improves drivers' propensity to give way	
(7) On street trials	Drivers' propensity to give-way improved at both sites, with a majority giving way at both sites with the non-prescribed crossing
(6) Simulator trials	The non-prescribed zebra is more likely than no crossing to get drivers to allow pedestrians to cross at side roads

(4) User surveys	Significantly more drivers reported that they would give way when presented with a non-prescribed crossing
Finding: Pedestrians are more likely to cross where a non-prescribed crossing is provided	
(4) User surveys	Pedestrians reported higher perceived safety when shown a junction with a non-prescribed zebra crossing compared to a junction with no crossing and were more likely to expect drivers to give way to them.
Finding: Compliance is worse for drivers turning into the side road than out of the side road	
(7) On street trials	Giving way was significantly lower for vehicles turning right into the side-road than for those turning out.
(6) Simulator trials	Drivers turning right into the side road were less likely to give way than those turning out.
(4) User surveys	Drivers reported lower willingness to give way to pedestrians when turning into the side road
(1) Analysis of collision data from existing crossings	Vehicles turning right were found to pose a significantly greater risk of collision with pedestrians than those turning left
Finding: Compliance may be worse when there are following vehicles	
(4) User surveys	Drivers' comments indicate concerns about giving way to pedestrians when there are following vehicles
Finding: Feedback from disabled users' needs to be considered in site selection and design	
(5) Surveys of users with disability	Concerns about vehicles approaching from behind on main carriageway-having to look behind and speed. Blind and visually impaired users concerned about drifting into main carriageway. Factors influencing level of concerns: following vehicles, vehicles approaching from behind, traffic speed and noise, large vehicles, legibility of crossing.
Finding: 'Non-full' markings do not introduce additional risks compared with 'full' crossings	
(1) Analysis of collision data from existing crossings	Sites with 'non full' markings were not found to have a worse collision record than 'full crossings' (both compared against nearby sites with no crossing).
(2) Public perceptions of existing crossings	Drivers reported no difference in subjective ratings of visibility between the crossing types. Most drivers believed pedestrians had priority for both crossing types
Finding: Zebra markings are better recognised than alternatives	
(3) Reaction time study	Zebra markings performed significantly better than all the alternatives in recognition and safety
(6) Simulator trials	Participants found it easiest to recognise the crossing and to decide whether to give way with a non-prescribed zebra crossing than with a 'footprint' crossing

4 Recommendations

Based on the research undertaken in this programme, it is recommended that regulatory approval is sought so that non-prescribed zebra crossings can be implemented at a larger number of sites for long-term monitoring. This would permit evidence to be obtained from a greater range of street environments than was able to be considered in the trials and over a longer timescale. With a larger sample of sites, and longer-term data, ongoing Stats-19 data collection could be used to investigate trends, rather than detailed observations being required at individual sites.

It is important to be aware of the limitations of the programme in terms of the number of sites considered and the range of variables measured both from the trials and in the simulator study. This means that the effects of different traffic flows and speeds were not assessed quantitatively, nor physical design variables such as turning radius or carriageway width. Video observations and simulator trials were not undertaken under night-time lighting conditions. Furthermore, there are indications from the user surveys that the presence of a following vehicle might affect driver willingness to give way; however, queuing was not observed at either of the two trial sites so this could not be investigated.

For these reasons it would be prudent to develop a phased approach to longer term trials, beginning with validating the findings from the current trials at a larger number of comparable sites, before progressing to sites with a greater range of environments, including traffic flows, pedestrian numbers, traffic speed and geometry. Sites would require good street lighting to ensure that the markings are clearly visible at night-time. Specific trials focused on night-time visibility may be helpful. Concerns about vehicles turning into the side road would suggest that sites with significant proportions of traffic turning right into the side road may present risks requiring suitable mitigation. Choosing sites with very tight, low radius, geometry will help to minimise turning speed and improve driver sight lines, mitigating these concerns. This would also help address the concerns of some user groups, for example, those of visually impaired users' about straying into the carriageway, and those concerned about the difficulty of judging vehicles approaching from behind.

Consideration also needs to be given to some of the concerns made in qualitative user feedback. This indicated that factors such as the presence of large vehicles, or high traffic noise, as well as junction geometry, will be of particular concern to certain disability groups. Some specific measures might include:

- Ensuring there is always a clear path with correct tactile paving to guide users safely across.
- Awareness raising could help improve user understanding of the priorities. This could be linked to the forthcoming Highway Code changes, which will themselves give greater priority to people crossing side roads in general.
- Specific training of vulnerable users may be appropriate, including working with groups local to crossing sites.

It is important to note that non-prescribed crossings would represent an additional crossing option available to highway engineers, not a replacement for existing crossing types. Their installation would need to take account of the local situation and potentially require

additional measures to reduce traffic speed or mitigate other risks as part of the design. Forthcoming changes to the Highway Code will reinforce the priority given to pedestrians crossing at side roads. Public awareness campaigns in support of further trials of the proposed crossings could therefore include information about these upcoming changes to the Highway Code, helping to improve drivers' understanding, awareness and willingness to give way at non-prescribed side road zebra crossings

Non-prescribed zebra crossings at side roads

Transport for Greater Manchester (TfGM) commissioned TRL to investigate the potential use of non-prescribed zebra crossings at side roads. The research programme followed seven studies, beginning with analysis of collision statistics, progressing through user surveys and interviews, simulation studies and culminating in two on-street trials.

The introduction of non-prescribed crossings was found to increase the propensity of drivers to give way, without increasing the level of conflict. Compliance was lower for drivers turning right, and other potential risk factors were identified for which mitigations could be considered in future trials. Further trials are recommended to gain evidence from a wider range of sites over a longer time period.

Other titles from this subject area

PPR1004	Non-prescribed zebra crossings at side roads. Technical Annex 1: Analysis of collision records at existing sites. Hammond J. and Simms G. 2019
PPR1005	Non-prescribed zebra crossing at side roads. Technical Annex 2: User surveys at existing sites. Verwey L., Novis K., Wallbank C. and Stuttard N. 2020
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PPR1008	Non-prescribed zebra crossing at side roads. Technical Annex 5: Implications for people with disability. Blunden A., Gupta B., Verwey L., Butler, R. and Wallbank C. 2021
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