Safe Speeds Phase 1 Interim Evaluation period ending December 2023

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Quality Assurance Information

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1. Introduction

1.1 Monitoring and Evaluation Plan

This report encompasses the monitoring and evaluation of Phase 1 of the Safe Speeds Programme.

It is part of a suite of three reports including:

- Safe Speeds Phase 1 Interim Evaluation period ending December 2023 (This Report);
- Safe Speeds Phase 2 Interim Evaluation period ending December 2023; and
- Safe Speeds Phase 1,2 and 3 Interim Evaluation period ending December 2023.

Anticipating the need for a comprehensive assessment, Auckland Transport (AT) formulated a Monitoring and Evaluation Plan in 2019. The primary purpose of monitoring and evaluating the effects of speed limit changes is to understand the programme's performance. This information serves as a foundation for informed decision-making and aids in identifying areas where additional interventions may be necessary to achieve safe and appropriate travel speeds.

Abley was commissioned to evaluate the following aspects of Phase 1 and Phase 2 of the Safe Speeds Programme (Figure 1.1). Each phase of the Safe Speed Programme includes a different set of roads with speed limit changes.

Speed:

- Geospatial speeds
- The difference between posted speed limit and mean speeds

Traffic Efficiency:

- Travel times

Crashes, Deaths & Serious Injuries

- Speed related crashes
- Crash data

Figure 1.1 Evaluation measures included in this analysis

1.2 Previous reports

Two previous reports evaluate the Safe Speeds Programme as outlined in Figure 1.2. The Safe Speeds Phase 1 18-Month Interim Evaluation report (dated June 2022) and the Safe Speeds Phase 1 24-Month Interim Evaluation (dated November 2022). This current suite of reports has more up-to-date data than the previous reports.

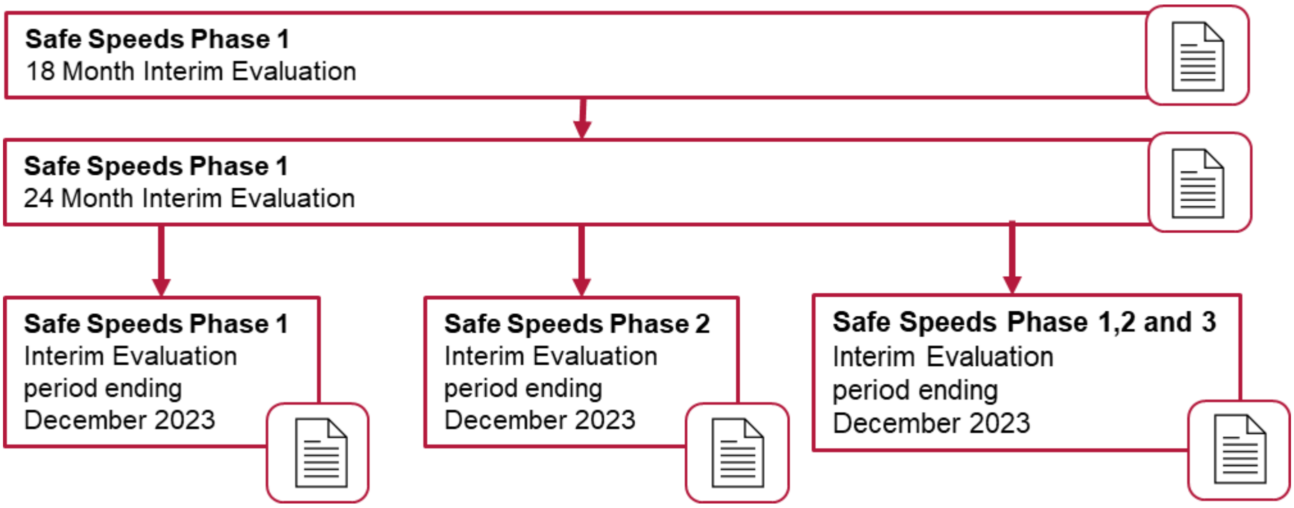

Figure 1.2 Published Safe Speed Evaluation Reports

1.3 Background

In 2017, Auckland found itself in the midst of a Road Safety Crisis, evidenced by 65% increase in road Deaths and Serious Injuries (DSI) from 2013 to 2017. In 2017 alone, the City recorded 64 deaths and 749 serious injuries, reaching a level of road trauma not witnessed in two decades. This surge in incidents surpassed the growth rates in population and vehicle travel, and disproportionately affecting pedestrians, cyclists, and motorcyclists.

Responding to this escalating road trauma, Auckland Transport's board commissioned an independent Road Safety Business Improvement Review (BIR) in November 2017. This comprehensive review presented extensive recommendations on how AT could spearhead a partnership-based response to save lives and prevent injuries. The BIR, coupled with the 10-year Road Safety Programme Business Case (PBC), laid the groundwork for implementation of a speed management programme aimed at tackling the increase in DSI crashes.

To date, three phases of the Safe Speeds Programme have been implemented. Appendix A details these phases including maps, speed limit changes and dates of implementation.

2. Methodology

The interim evaluation of the Safe Speeds Programme incorporates two types of before-after analysis. Together, these two before and after analyses demonstrate the road safety effectiveness of the Safe Speeds Programme. These include a:

1. Before and after crash data analysis, that assessed the actual change in all injuries, serious injuries and deaths per year. This provides a direct insight into the impact on injuuries resulting from the speed limit changes.
2. Before and after speed data analysis, that looks at the variation in operating speeds observed across the roads where speed limits were changed. This measures the speed changes adopted by drivers in response to the reduced speed limits.

A reduction in injury numbers is considered a direct measurement of improvements in road safety outcomes. Given the strong relationship between operating speeds and injuries, the lowering of speeds is an indirect (or surrogate) measure of improved road safety outcomes. The before and after assessment of operating speed changes was carried out for all three phases of the programme. There were only sufficient years of after crash data to do crash data analysis for phases 1 and 2.

2.1 Crash data analysis

Crash data sourcing and allocation

Crash data from the NZ Transport Agency Crash Analysis System was used in this analysis. The annual average injuries over the five-year period preceding the speed limit change were calculated and compared with the crash data observed in the months following the implementation of the speed limit changes.

Given the diverse dates of speed limit adjustments across different roads, distinct before-and-after periods were employed, aligning with the respective implementation dates. For instance, if a speed limit change was implemented on a road on 30 June 2020, the before period spanned from 30 June 2015 to 30 June 2020, while the after period extended from 1 July 2020 to 31 December 2023.

The percentage change in injury rate was determined by the change in DSI divided by the DSI Before.

$$Percentage\ change\ in\ injury\ rate = \frac{DSIs\ After - DSIs\ Before}{DSIs\ Before} \times 100\%$$

Equation 2.1 Percentage change in injury rate

However, to take into account other factors impacting injury risk, like Covid, injury trends on the part of the network without speed limit changes were used as a comparison group. Potential factors include:

- Changes during the COVID-19 lockdowns;
- Extreme weather conditions in Auckland;
- Changes in Auckland vehicle fleet over time; and
- Influence of road safety campaigns

The percentage change between expected and actual injury rates is shown in Equation 2.2 below:

$$\begin{aligned}&Percentage\ change\ between\ expected\ and\ actual\ injury\ rate\\&\qquad = Percentage\ change\ in\ injury\ rate\ (Targeted\ sites)\\&\qquad - \ Percentage\ change\ in\ injury\ rate\ (Comparison\ sites)\end{aligned}$$

Equation 2.2 Percentage change between expected and actual injury rates

Appendix B (Speed data analysis) describes how external factors were addressed in the analysis.

For the scaling analysis, DSI values were adjusted according to their respective modes and corresponding underreporting factors. The table below presents the scaling factors used for each mode. In this analysis, motorcyclists have the highest underreporting factor, leading to the highest scaling factor. For instance, for every 10 reported motorcycle DSI, it is estimated that an additional 19 motorcycle DSI go unreported.

Table C1.1 Reduced scaling factors table (ViaStrada 2022)[1]

Mode	Crash type	Total Mode Scaling Factor
Pedestrian	Pedestrian vs vehicle	2.51
Bicycles	Cycle vs vehicle	2.19
Motorcycles	Total motorcycle	2.90
Total other motor vehicles		1.96

2.2 Speed Change Analysis

Alongside the injury crash analysis, changes in operating speeds were used as a surrogate measure to better understand road safety improvements due to the speed management programme. In the short term the speed analysis is considered a more accurate reflection of the actual change in risk across the network, due to fluctuations in injury crashes that are typically observed in short after periods. Typically, between three and five years of after data (depending on number of crashes impacted by the treatment) should be analysed before being confident in the observed change in injuries, especially for the more rare crash types (eg. fatalities). The speed data on the other hand, has much greater sample sizes and thus can be used to infer changes in injury risk relatively quickly.

The speed data analysis utilised TomTom data, a network wide data source of probe speeds based on actual vehicle travel speeds. TomTom collects speed data through various sources including GPS devices, connected vehicles and crowdsourced data. This gives a comprehensive understanding of average operating speeds across all of Auckland.

TomTom data from both November 2019 and November 2023 was obtained for the analysis. The speeds recorded in November 2023 were then compared to the data from November 2019 at a segment level. Changes in speeds greater than 50% were removed from the analysis as outliers. These are likely to be influenced by external factors, such as temporary traffic management, or data errors.

Using the models of Elvik and Nilsson, that measure the relationship between speed and various levels of crash severity (eg. fatal injury risk and serious injury risk), the analysis was able to predict the impact of speed changes on the various injury levels at the segment level.

Subsequently, the observed speed changes and associated changes in injury risk were aggregated across the entire network to determine the overall impact of the Safe Speeds Programme. Equation 2.3 and Equation 2.4 demonstrate how predicted DSI changes per year were calculated.

[1] ViaStrada (2022) Safety of people travelling outside vehicles, Deep dive review: First and second phase, prepared for Auckland Transport

As the exponent in the Estimated DSI After equation is always greater than one, if speeds increase so too does the DSI.

$$Estimated\ DSI\ After = DSI\ \ Before\ x\ (\frac{Speed\ After}{Speed\ Before})^{exponent}$$

Equation 2.3 Nilsson Power Model - where the exponent is 3.5 on rural corridors and 2.0 on urban corridors

In order to consider external factors, the predicted change in DSI takes into account the change in the entire network. To achieve this, the change in predicted DSIs for the rest of the network is subtracted from the change on the specific focus roads. This is because the change in the rest of the network is anticipated to be influenced by external factors that would affect the focus roads in a similar manner to the comparison group.

$$Predicted\ DSI\ change\ per\ year =$$

$$Predicted\ DSI\ percentage\ change_{Focus\ roads} - \ Predicted\ DSI\ percentage\ change_{Remaining\ network}$$

Equation 2.4 Estimated DSI changes from speed analysis (November 2019 and 2023 comparison)

3. Evaluation Results

This section discusses the results of the interim analysis of Phase 1 of the Safe Speeds Programme including both the crash data and speed analyses.

3.1 Crash data analysis

The crash data analysis considers two approaches. Firstly, the actual change in the number of injuries from the before period to the after period; this is called a naïve before and after analysis. In the second approach the expected injury value for the after period, if the speed limit had not changed, is used. This takes into account changes that have occurred over the network between the before and after period, like changes in traffic flows. The difference between the second injury value (what would have occurred in the after period if the speed limit had not changed) and what was observed in the after crash period (as a result of the speed change) is a more accurate estimate of the speed limit change on injury risk; this is called a before and after comparison group analysis.

Whilst reductions in injury rates from the before period to the after period are provided, these do not consider the high number of external factors influencing injury risk over time, such as the COVID-19 lockdown periods.

Overseas research on COVID-19 impacts shows that while injuries generally decreased during lockdowns due to fewer vehicles on the road, the severity of collisions and fatalities often increased as free-flowing traffic led to higher speeds. As a result, the observed injury reductions between the before and after periods reflect changes at each location but do not accurately represent the broader safety benefits of the Safe Speeds Programme. Since the full impact of COVID on injuries in both periods is not quantifiable, a comparison group analysis using the rest of the Auckland network has been applied to account for these factors.

Reported injury analysis

Table 3.1 shows the results of the before and after comparison and indicate a notable decrease in injuries from the before period to the after period on Phase 1 roads. This shows that there were less injuries per annum following implementation of the Safe Speeds Programme at the treated sites. However, comparison group site analysis is the more robust evaluation of the programme's network impact. The comparison group site analysis identified reductions as follows:

- 45% reduction in fatalities,
- 16% reduction in serious injuries, and
- 24% reduction in minor injuries.

These reductions signify positive outcomes in terms of safety across the roads subject to the speed limit changes. Whilst these reductions are encouraging, the post-analysis periods are still less than the ideal five year after period and hence why they should only be considered interim results.

Table 3.1 Summary of before and after injury comparison (December 2023 evaluation)

Injury type	Injury rate before speed limit change (per year)	Injury rate after speed limit change (per year)	Percentage change in injury rate	Expected injury rate (per year) with no speed limit change	Change between expected and actual injury rate (per year)	Percentage change between expected and actual injury rate	Change between expected and actual injury rate (Total) - Cumulative benefit
Fatal	6.4	3.6	-44%	6.6	-3	-45%	-10.4
Serious	72.6	57.2	-21%	68.1	-10.9	-16%	-37.8
Minor	325.2	239.7	-26%	314.2	-74.5	-24%	-258.2
DSIs	79	60.8	-23%	74.7	-13.9	-19%	-48.1
All injuries	404.2	300.5	-26%	388.9	-88.4	-23%	-306.4[2]

Rural and urban changes in injuries

An analysis was conducted to show the effectiveness of speed limit changes in urban and rural road environments. By considering the specific characteristics and challenges associated with urban versus rural environments, this analysis aims to provide nuanced insights into the effectiveness of the Safe Speeds Programme in these different environments.

It is important to note that this analysis focuses specifically on the changes in injuries on the roads subjected to speed limit modifications.

Phase 1 rural roads saw a larger reduction in the severity of road trauma than all roads combined, with a:

- 56% decrease in fatalities;
- 26% decrease in death and serious injury collisions; and
- 26% reduction in all injuries.

The rural road results align with research that indicates speed changes have a greater effect on higher severity injuries than lower severity injuries.

Phase 1 urban roads have not experienced the same significant reduction in the higher severity injuries. On urban roads:

- Fatalities reduced by 6%;
- Death and serious injuries decreased by 20%; and
- All injuries on urban roads decreased by 27%.

Urban roads had a relatively low number of fatal crashes in the before and the after period so less confidence can be placed on the changes experienced by this crash severity.

[2] The term "expected injuries" has been applied. This refers to the number of injuries that are anticipated to occur in the future period on the focus roads if the speed limit had not changed.

Table 3.2 Phase 1 rural and urban summary of before and after injury comparison (December 2023 evaluation)

Land use	Injury type	Injury rate before speed limit change (per year)	Injury rate after speed limit change (per year)	Percentage change in injury rate
Rural	Fatal	4.8	2.1	-56%
	Serious	35	27.3	-22%
	Minor	133.2	101.5	-24%
	DSI	39.8	29.4	-26%
	All	173	130.9	-24%
Urban	Fatal	1.6	1.5	-6%
	Serious	37.6	29.9	-20%
	Minor	192	138.2	-28%
	DSI	39.2	31.4	-20%
	All	231.2	169.6	-27%

The smaller reduction in death and serious injury collisions on urban roads is consistent with the modified form of Nilsson's Power Model, where a smaller exponent is applied on urban roads compared to rural roads. The modified form of Nilsson's Power Model used to predict the change in deaths and serious injuries (DSI) following a speed limit change is:

$$Estimated\ DSi\ Crashes\ After = DSi\ Crashes\ Before\ x\ \left(\frac{Speed\ After}{Speed\ Before}\right)^{exponent}$$

Equation 3.1 Nilsson Power Model - where the exponent is 3.5 on rural corridors and 2.0 on urban corridors.

3.2 Under-reporting rate adjustments - scaled serious injury analysis

To address the impact of under reporting of serious injuries, an analysis was undertaken using scaling factors, that were derived from an analysis of hospital and CAS data. This provided a better estimate of the overall reduction in DSIs of the Safe Speed Programme. Scaling factors are available in the 'Safety of people travelling outside vehicles' report (ViaStrada 2022)[3]. Further details regarding the steps in this analysis are provided in Appendix D.

The 39% increase in cyclist DSI is likely affected by the small sample size of cyclist DSI both on the road with speed limit changes and in the comparison group.

The scaled injury data analysis shows that the Phase 1 speed limit changes reduced DSIs by 33.3 annually (19%). Therefore, over a 10-year period, the analysis estimates 333 less people will be seriously injured or killed as an outcome of the Phase 1 speed limit reductions.

[3] ViaStrada (2022) Safety of people travelling outside vehicles, Deep dive review: First and second phase, prepared for Auckland Transport.

Table 3.3 Serious injury analysis (taking into account under reporting)

Crash type	Focus roads- annual estimated DSI before (scaled)	Roads with speed limit changes - % Change in annual scaled DSIs	Rest of network - % Change in scaled DSIs	Percentage change between expected and actual injury rate	Estimated annual change in DSI
Cycle	11.7	12%	-27%	39%	4.6
Motorcycle	42.9	-32%	-7%	-24%	-10.4
Other	91.3	-25%	-3%	-22%	-20.3
Pedestrian	30.6	-20%	4%	-24%	-7.2
Total	176.5	-24%	-5%	-19%	-33.3

3.3 Speed change analysis (November 2019 and November 2023)

The speed analysis derived using TomTom operating speed data, shows that mean speeds reduced by an average of 7% on rural roads and by 6% on urban roads included in the Phase 1 speed management programme. Over the same period, rural roads across the rest of the Auckland network also saw a 4% reduction in rural speeds and a 4% reduction in urban speeds. However, it is unclear if this result was impacted by the change in speed limits on surrounding roads.

Table 3.4 Rural and urban summary of speed changes (November 2019 and 2023 comparison)

Phase	Road type	Average speed percentage change on focus roads
Phase 1	Rural	-7%
	Urban	-6%

3.4 Changes in 85th percentile speeds by road segment

Alongside the mean speed changes, the change in 85th percentile speeds also provides insight into crash risk across the network. Figure 3.1 illustrates the change in the 85th percentile speeds on a segment-by-segment level. Generally, there has been a reduction in the 85th percentile speed, as indicated by the higher proportion of roads shown in green and dark green, compared to those shown in either orange or red. However, some road clusters have seen an increase in the 85th percentile speed following the speed limit changes. These roads tend to be either lower speed urban roads or windy rural roads. In both of these instances, it is likely that the 85th percentile speed before the speed limit reductions was closer to the new speed limits. On these types of roads, we would expect to see less impact from the speed limit changes because most drivers do not need to change their speeds to drive below the new speed limit. In these cases, the 85th percentile speed is likely more dependent on the congestion of the road and the road conditions (eg. road alignment and cross-section).

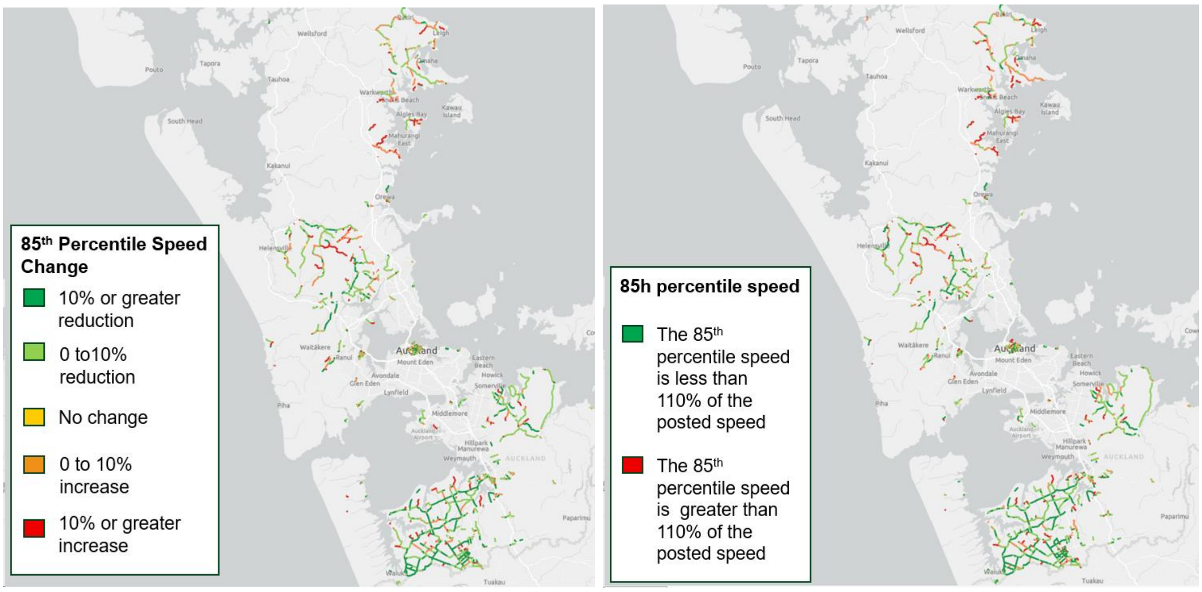

Figure 3.1 Phase 1 change in 85th percentile speed (left figure is direction 1 and right figure is direction 2)

3.5 DSI change estimation from operating speed changes

Using road safety research, it is possible to estimate likely reductions in DSI from operating speed changes. Given the relatively short after period, this estimated change in crash risk is often a more reliable predictor of the long-term annual injury reduction, than what is observed in the after-crash data.

The estimated injury reduction for the Phase 1 programme is a 22% reduction in DSI on rural roads and a 11% reduction on urban roads.

While the change in reported rural DSIs (26% reduction) is similar to the predicted rural DSI change (22% reduction), the change in reported urban DSIs (20% reduction) is greater than the predicted urban DSI change (11% reduction). However, the injury analysis is likely to have been impacted to a greater degree by external factors such as COVID-19 than the speed analysis. Thus, it is important to understand that this is not a straightforward comparison between the two outcomes.

Table 3.5 Rural and urban summary of predicted DSI changes (November 2019 and 2023 comparison)

Phase	Road type	Predicted DSI change Phase 1 roads
Phase 1	Rural	-22%
	Urban	-11%

3.6 Fatality change estimation from speed analysis

Alongside the DSI reduction, the speed analysis identified an estimated reduction in fatalities. Given the relatively short after period, this surrogate measure of risk is expected to reflect the long-term effects of the Safe Speeds programme more accurately than the injury analysis. The speed analysis estimated a 27% reduction in fatalities on rural Phase 1 roads and a 15% reduction on urban Phase 1 roads.

Table 3.6 Phase 1 predicted change in fatalities (November 2019 and 2023 comparison)

Phase	Road type	Predicted change in fatalities Phase 1 roads
Phase 1	Rural	-27%
	Urban	-15%

3.7 Compliance and travel time analysis

The speed analysis showed that 6% of Phase 1 road lengths have mean speeds more than 5km/h above the new posted speed limit, and 27% of road sections have 85th percentile speeds more than 10% above the speed limit.

This shows there is a relatively poor level of compliance with the new speed limits which is consistent with international literature which indicates that speed limit reductions cause a lower reduction in mean speeds. If compliance improved then significantly better safety outcomes would be expected, as per Nilsson's power model. It is worth noting that overall speeds have decreased, resulting in better road safety outcomes.

Poor compliance generally seems to be a greater issue for urban roads, especially those without accompanying speed calming infrastructure. Analysing the travel times for Phase 1 roads identified there has been a 7% increase in travel times on roads where speed limits have changed.

Table 3.7 Phase 1 travel time evaluation

Phase	Land use	Travel time change Phase 1 roads
Phase 1	Urban	7%
	Rural	8%
	All roads	7%

4. Conclusions

4.1 Injury analysis

Reported injury rates

The difference between the Phase 1 sites and the comparison sites showed a 19% reduction in DSI; and a 23% reduction in all injuries. Please note that these figures are interim results, as the current after period is less than five years.

Predicted change in injury rates

Nilsson's modified power models were applied to the new speeds on each of the segments to estimate injury reductions. This identified a 22% reduction in DSI on rural roads and a 11% reduction on urban roads.

Total fatal and serious injury rates (scaled for under reporting)

A scaled analysis was undertaken taking into account under reporting of crash data. This analysis showed an overall 19% reduction in DSI for Phase 1 of the Safe Speeds Programme. This translates to approximately 333 fewer deaths and serious injuries on the Phase 1 roads over a 10 year period.

4.2 Speed analysis

Speed

The speed analysis shows that mean speeds reduced by an average of 7% on rural roads and by 6% on urban roads included in the Phase 1 speed management programme.

Speed limit compliance

The speed analysis showed 6% of Phase 1 road sections have mean speeds more than 5km/h above the new posted speed limit, and 27% of road sections have 85th percentile speeds more than 10% above the speed limit.

This shows there is a relatively high level of non-compliance with the new speed limits which is consistent with international literature which indicates that speed limit reductions cause a lower reduction in mean speeds. If speed limit compliance improved then significantly better safety outcomes would be expected, as per Nilsson's power model. The analysis shows, however, that drivers are generally travelling slower, indicating better alignment with safe and survivable speeds. This results in overall improved road safety outcomes.

Travel time impacts

Travel time analysis of the Phase 1 roads found there was a 7% increase in travel time on roads where speed limits were changed.

4.3 Summary

Evaluation of Phase 1 of the Safe Speeds Programme shows a reduction in high severity injury risk and all injury risk. It also shows that the increase in travel times is relatively minor. At the same time, while speed limit compliance may be worse the number of drivers travelling below safe system speeds has improved, resulting in better overall road safety outcomes.

While the reductions are encouraging, the after period is relatively short, and extended lockdowns in Auckland during this time likely impacted travel patterns. COVID-19 may have influenced congestion, vehicle speeds, and exposure to collisions. As the overall impact of COVID on injuries in both periods is not fully quantifiable, a comparison group analysis has been used to account for these factors.

To further reduce deaths and serious injuries, it is necessary to take more action on other parts of the Safe System to reduce speeds. This includes implementing safer road designs that encourage lower speeds and increasing speed enforcement.

Appendix A.
Safe Speed Phases

A1. Safe Speeds Phasing

This Appendix shows the speed limits implemented in each of the respective phases of the Safe Speeds Programme. Each phase has several implementation dates, representing the different days when the speed limit signage was installed on the ground.

A1.1 Safe Speeds Phase 1

On June 30, 2020, Auckland Transport initiated Phase 1 of the Safe Speeds Programme. This phase encompassed the implementation of speed adjustments on approximately 11% of Auckland's local road network, equating to over 800 kilometres. The primary focus was on establishing safe and appropriate speed limits across this extensive network.

The roads selected for Phase 1 comprised a diverse mix. This inclusive approach targeted roads in high-risk rural zones, the city centre, various town centres, residential areas, and urban roads. The overarching goal of these speed limit changes was to achieve a substantial reduction in Death and Serious Injuries (DSI) on the affected roads.

Figure A1.1provides a visual representation of the Phase 1 roads within the Safe Speeds Programme, outlining the new speed limits.

Implementation dates for Phase 1 include:

- 30/06/2020
- 31/05/2021
- 06/06/2021

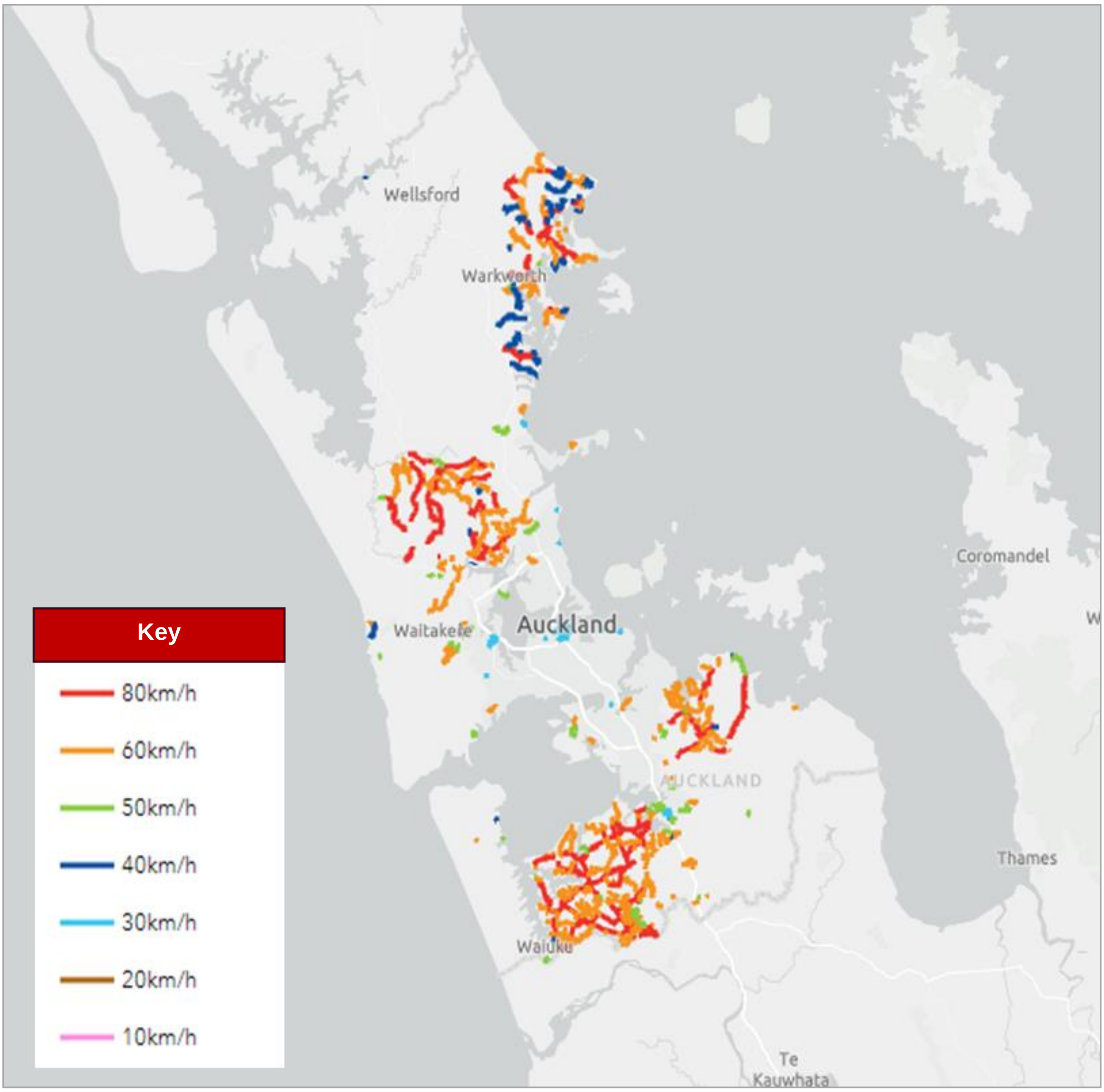

Figure A1.1 Phase 1 Speed limit changes in Auckland (2023)

A1.2 Safe Speeds Phase 2

In May and June 2022, Auckland Transport implemented Phase 2 of the Safe Speeds Programme. This included the delivery of speed changes on approximately 800 roads including approximately:

- 462 roads near 57 Auckland schools
- 208 roads in Franklin
- 10 roads in Ōtara town centre
- 80 roads in Manurewa
- 41 roads, mostly, in Freemans Bay and Ponsonby

Implementation dates for Phase 2 include:

- 30/06/2022
- 14/07/2022
- 21/07/2022
- 28/07/2022

Figure A1.2 shows the Safe Speeds Programme Phase 2 roads and their new speed limit.

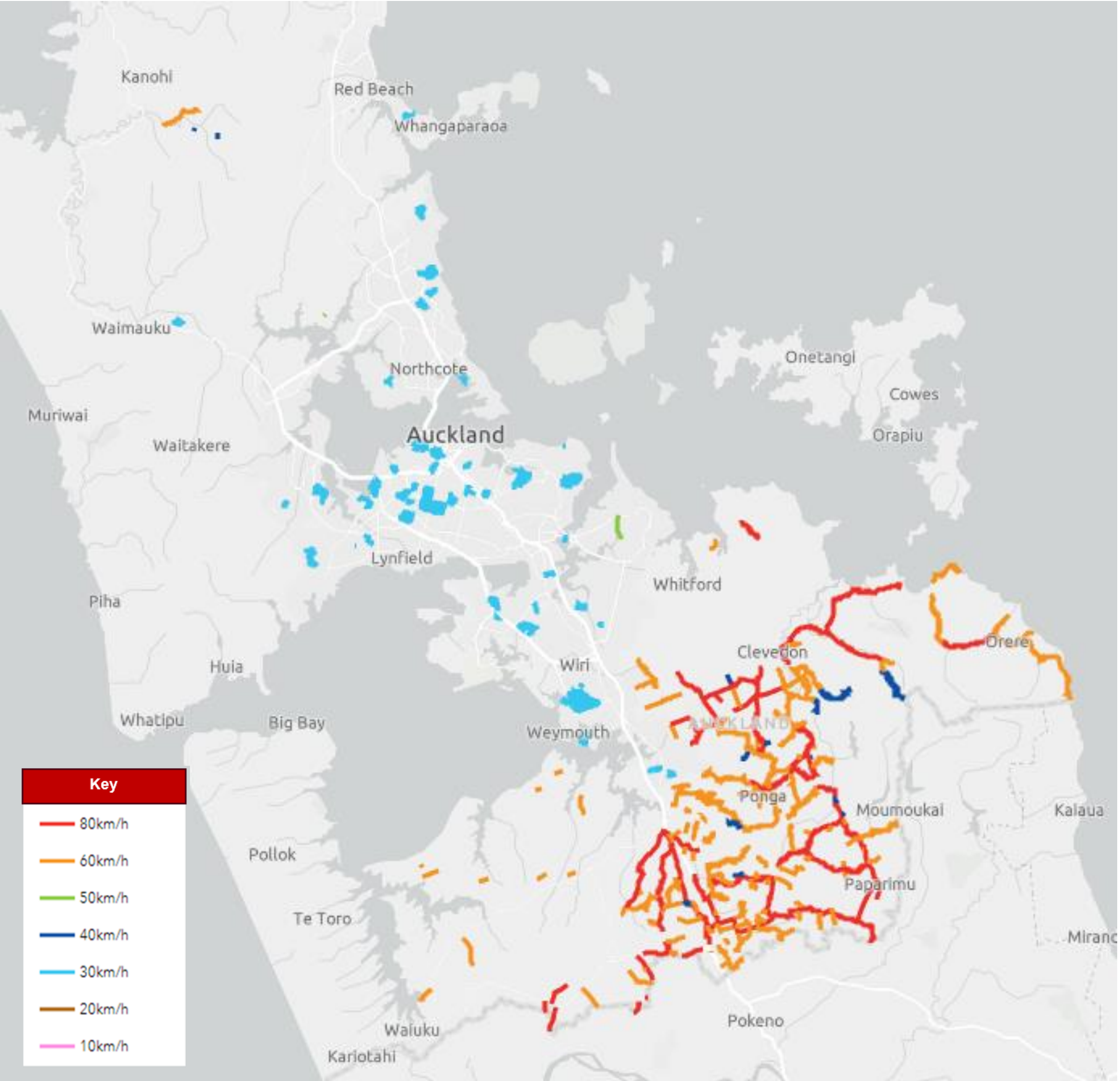

Figure A1.2 Phase 2 Speed limit changes in Auckland (2023)

A1.3 Safe Speeds Phase 3

Phase 3 includes roads around 75 schools, Takapuna, Devonport and Glen Innes, a residential area in Manurewa, roads outside of rural marae across the region, roads which have been requested by the community and all of Waiheke Island.

Implementation dates for Phase 3 include:

- 01/12/2022
- 26/01/2023
- 02/03/2023
- 30/03/2023

Figure A1.3 Phase 3 Speed limit changes in Auckland (2023) shows all speed limit planned for changes in Phase 3.

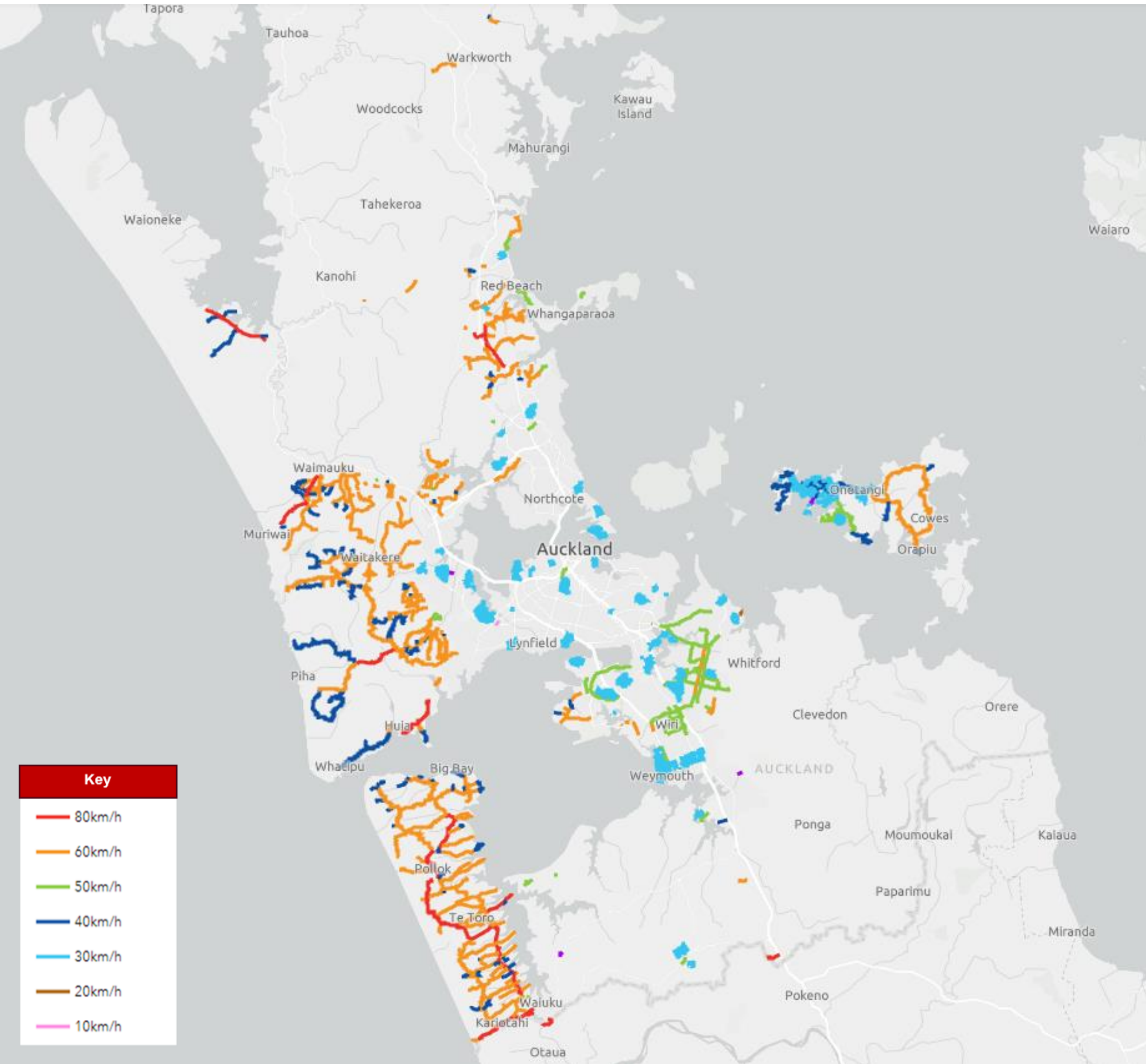

Figure A1.3 Phase 3 Speed limit changes in Auckland (2023)

Appendix B. External Factors

B1. External factors

Several external factors, not directly related to the effectiveness of the programme, impacted the analysis. These factors can affect the evaluation of the before and after data. Key external factors are summarised here and discussed in more detail in Appendix A.

B1.1 COVID-19

During COVID-19 lockdowns, traffic volumes on Auckland's road network decreased significantly. Traffic volumes during April 2020 were approximately 10-15% pre-pandemic levels. Decreases were seen during Auckland's subsequent lockdowns, but not to the same extent.

A significant impact of the pandemic has been the effect of changing work behaviours on traffic volumes. It is now far more common for people to work from home. This has resulted in a decrease in traffic volumes in non-lockdown periods. A small decrease in traffic volume can have significant effects on traffic congestion and improve the flow of traffic. Therefore, whilst not quantified, it can be expected that the COVID-19 pandemic lockdowns and ongoing behaviour change have affected the free-flow and operating speeds on Auckland's road network.

B1.2 Population fluctuation

Fluctuations in population impact travel demand and the number of people on the roads which in turn affects the number of Crashes and injuries seen on the road network. This will thus impact the number of injuries occurring before compared to after the speed limit changes and should be accounted for as part of the analysis.

B1.3 Fleet changes

New Zealand's vehicle fleet is continuing to evolve, with new technologies resulting in less severe outcomes when injuries occur, thus impacting on the severity of reported injuries.

B1.4 Regression to the mean

Regression to the mean occurs where there is an unusually high (or low) number of injuries in the before period data. If no changes are made to the transport network, it is likely that locations with injury numbers significantly above their mean will reduce in the next sampling period and increase where the injury numbers are significantly below the mean.

In the case of the Phase 1 and Phase 2 analyses, regression to the mean is not expected to play a substantial role. Roads were selected on an area-wide basis rather than an individual road basis based on Crash history. As such, regression to the mean is not accounted for in this analysis.

B1.5 Weather

During a short evaluation period, the weather can impact in the number of vehicles on the road and their travel speeds. It is expected that the relatively high sample size will help address the impacts of individual weather events; however, sustained periods of poor weather could impact the data. Given the uncertainty around this, no adjustment for weather has been allowed for in this analysis.

B1.6 Discussion

The comparison group method will mitigate these issues, particularly the concern of regression to the mean. Given the substantial changes in the network, regression to the mean is unlikely to pose a significant problem, reducing the bias associated with selecting high-crash sites. While this effect might be more noticeable during Phase 1, it is expected to diminish as more of the network undergoes treatment, making injuries reductions less susceptible to the influence of regression to the mean.

Appendix C.
Local Board Injury Breakdown December 2023 analysis

C1. Local Board Injury Breakdown December 2023 analysis

Table C1.1 Local Boards and Speeds Breakdown

Phase	Implementation Date	Local Board	Proposed Speed	Fatal injuries per year - Before	Fatal injuries per year - After	Serious injuries per year - Before	Serious injuries per year - After	Minor injuries per year - Before	Minor injuries per year - After
Phase1	20200630	Franklin	40	0	0	0	0	0	0
Phase1	20200630	Franklin	50	0.2	0	0.8	1.1	5.4	3.4
Phase1	20200630	Franklin	60	0.4	1.4	7	7.1	33.2	19.7
Phase1	20200630	Franklin	80	2.8	0.9	18	11.4	62.8	47.4
Phase1	20200630	Henderson-Massey	30	0	0	0.8	0.6	4.8	2.9
Phase1	20200630	Henderson-Massey	50	0	0	0	0	0	0.3
Phase1	20200630	Hibiscus and Bays	50	0	0	0	0	0	0
Phase1	20200630	Hibiscus and Bays	60	0	0	0	0	0.6	0
Phase1	20200630	Howick	50	0	0	0	0	0.2	0.9
Phase1	20200630	Howick	60	0.2	0.3	2.6	2	6	7.4
Phase1	20200630	Howick	80	0	0	0.4	0.3	1	0.3
Phase1	20200630	Mangere-Otahuhu	30	0	0	0.8	0.3	3	4.3
Phase1	20200630	Mangere-Otahuhu	50	0	0	0.4	0.3	2.6	1.4
Phase1	20200630	Mangere-Otahuhu	60	0	0	0.6	0.6	1	0.9
Phase1	20200630	Otara - Papatoetoe	60	0	0.3	0.4	0	2.4	1.4
Phase1	20200630	Papakura	30	0	0	1	0.6	2.4	2

Phase	Implementation Date	Local Board	Proposed Speed	Fatal injuries per year - Before	Fatal injuries per year - After	Serious injuries per year - Before	Serious injuries per year - After	Minor injuries per year - Before	Minor injuries per year - After
Phase1	20200630	Papakura	40	0	0	0.2	0.3	0.4	0.6
Phase1	20200630	Papakura	50	0.2	0.3	1.6	1.4	11.8	10
Phase1	20200630	Papakura	60	0	0	0.4	1.1	2.4	2
Phase1	20200630	Rodney	40	0	0	0.6	1.1	0.6	2.3
Phase1	20200630	Rodney	50	0	0	0.4	0	1.6	3.1
Phase1	20200630	Rodney	60	0.6	0.6	4	3.1	20.8	17.1
Phase1	20200630	Rodney	80	0.8	0	5.6	5.4	21.2	23.1
Phase1	20200630	Upper Harbour	40	0	0	0	0	0	0
Phase1	20200630	Upper Harbour	50	0.4	0	1	1.1	5.8	6.6
Phase1	20200630	Upper Harbour	60	0	0	0.8	0.6	3.6	2.9
Phase1	20200630	Upper Harbour	80	0	0	0	0	0.2	0
Phase1	20200630	Waitakere Ranges	30	0	0	0	0.6	1	1.1
Phase1	20200630	Waitakere Ranges	40	0	0	0	0	0	0
Phase1	20200630	Waitakere Ranges	50	0	0	0.8	0.3	0.6	0.6
Phase1	20200630	Waitakere Ranges	60	0	0	0	0	0.6	0
Phase1	20200630	Waitemata	10	0	0	0.2	0	1	0.6
Phase1	20200630	Waitemata	20	0	0	0	0.3	0.4	0.3
Phase1	20200630	Waitemata	30	0.6	0.3	17	13.4	96.4	56
Phase1	20200630	Waitemata	40	0.2	0	2.8	1.7	17.4	9.4

Phase	Implementation Date	Local Board	Proposed Speed	Fatal injuries per year - Before	Fatal injuries per year - After	Serious injuries per year - Before	Serious injuries per year - After	Minor injuries per year - Before	Minor injuries per year - After
Phase1	20201130	Hibiscus and Bays	30	0	0	0.6	0.6	2.6	1.6
Phase1	20210531	Rodney	40	0	0	0	0	0.6	0.4
Phase1	20210531	Rodney	50	0	0	0	0	0	0
Phase1	20210531	Rodney	60	0	0	0.4	0.4	0.6	0.8
Phase1	20210531	Rodney	80	0	0	1.4	0.4	1.6	1.5
Phase1	20210531	Waitakere Ranges	40	0	0	0	0	0	0
Phase1	20210531	Waitakere Ranges	50	0	0	0	0	0.8	0
Phase1	20210531	Waitakere Ranges	60	0	0	0.4	0	2.8	1.5
Phase1	20210606	Orakei	30	0	0	1.6	0.4	4.2	4.3
Phase1	20210606	Waitemata	30	0	0	0	0	0.8	0

Appendix D.
Scaled analysis

D1. Scaled Injury Analysis

D1.1 Injury analysis - taking into account under reporting

As discussed, DSIs are under reported in the Crash Analysis System. To overcome this limitation, the analysis used scaling factors derived from an analysis of hospital and CAS data. This helped to estimate the overall DSI by scaling up the CAS reported DSI. The scaling factors are available in the 'Safety of People Travelling Outside Vehicles' report (ViaStrada 2022) and are presented in the table below:

Table D1.2 Scaling factors Table (ViaStrada 2022)[4]

Category	Road User	Total Mode Scaling Factor
Pedestrians	Pedestrians only	5.06
	Pedestrians vs Vehicles	2.51
	TOTAL Pedestrians	*7.57*
Bicycles	Cycle only	4.91
	Cycle vs Vehicles	2.19
	TOTAL CYCLES	*7.10*
Transport Devices	TOTAL Transport DEVICES+	13.1
Cycles & Wheeled Transport Devices		**7.52**
TOTAL ACTIVE Transport MODES	User-only	4.89
	User vs Vehicles	2.66
	TOTAL	***7.55***
Motorcycles	Motorcycle only	1.57
	Motorcycle vs Vehicles	1.33

[4] ViaStrada (2022) Safety of people travelling outside vehicles, Deep dive review: First and second phase, prepared for Auckland Transport

Category	Road User	Total Mode Scaling Factor
	TOTAL Motorcycles	*2.90*
TOTAL VULNERABLE Transport MODES	User-only	3.26
	User vs Vehicles	2.02
	TOTAL	***5.27***
TOTAL OTHER MOTOR Vehicles		**1.96**
ALL TRANSPORT MODES	User-only	1.88
	User vs Vehicles	1.56
	TOTAL	**3.44**

The table below shows the scaling factors used for the analysis. These values were deemed relevant based on the previous table.

Table D1.3 Reduced scaling factors table (ViaStrada 2022)[5]

		Total Mode Scaling Factor
Pedestrian	Pedestrian vs Vehicle	2.51
Bicycles	Cycle vs Vehicle	2.19
Motorcycles	*Total motorcycle*	*2.90*
Total other motor vehicles		**1.96**

The process can be seen in the Figure D1.4. Reported injuries were extracted for each of the road user categories and the scaling factors were applied as per the table above. These were then aggregated into the appropriate period, depending on the crash date, and divided to get the injuries per year. This gave the number of estimated DSI per year after implementation compared to the number of DSI per year before the implementation. The results of this analysis can be seen in Table D1.5.

[5] ViaStrada (2022) Safety of people travelling outside vehicles, Deep dive review: First and second phase, prepared for Auckland Transport

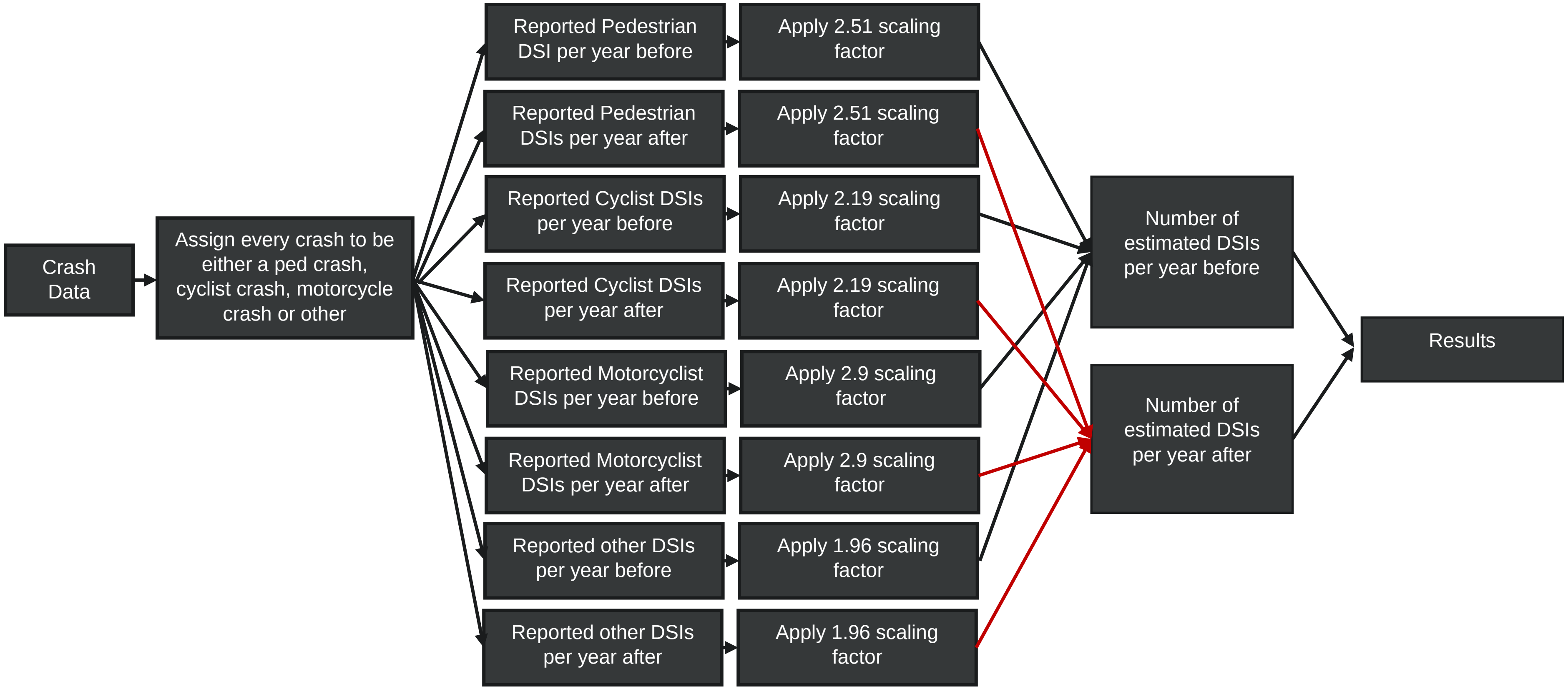

Figure D1.4 Under-reporting CAS data analysis

Table D1.4 Injury analysis (taking into account under reporting)

Crash type	Focus – annual reported DSI before (unscaled)	Focus - annual estimated DSI before (scaled)	Focus - annual reported DSI after (unscaled)	Focus - annual estimated DSI after (scaled)
Cycle	5.4	11.7	6	13.1
Motorcycle	14.8	42.9	10.1	29.3
Other	46.6	91.3	34.8	68.1
Ped	12.2	30.6	9.7	24.5
Total	79	176.5	60.6	135

Table D1.5 Injury analysis (taking into account under reporting)

Crash type	Focus - annual estimated DSI before (scaled)	Focus - % Change in estimated DSIs	Rest of network - % Change in estimated DSIs	Difference	Annual change in estimated DSI	Change
Cycle	11.7	12%	-27%	39%	4.6	Increase
Motorcycle	42.9	-32%	-7%	-24%	-10.4	Decrease
Other	91.3	-25%	-3%	-22%	-20.3	Decrease
Ped	30.6	-20%	4%	-24%	-7.2	Decrease
Total	176.5	-24%	-5%	-19%	**-33.3**	Decrease

Taking account under reporting, the scaled injury data analysis estimated Phase 1 speed limit reductions reduced DSIs by 33.3 annually. Therefore, over a 10-year period, the analysis estimates 333 less people will be seriously injured or killed as an outcome of the Phase 1 speed limit reductions.

Appendix E.
Change in 85th percentile speed

Change in 85th percentile speed

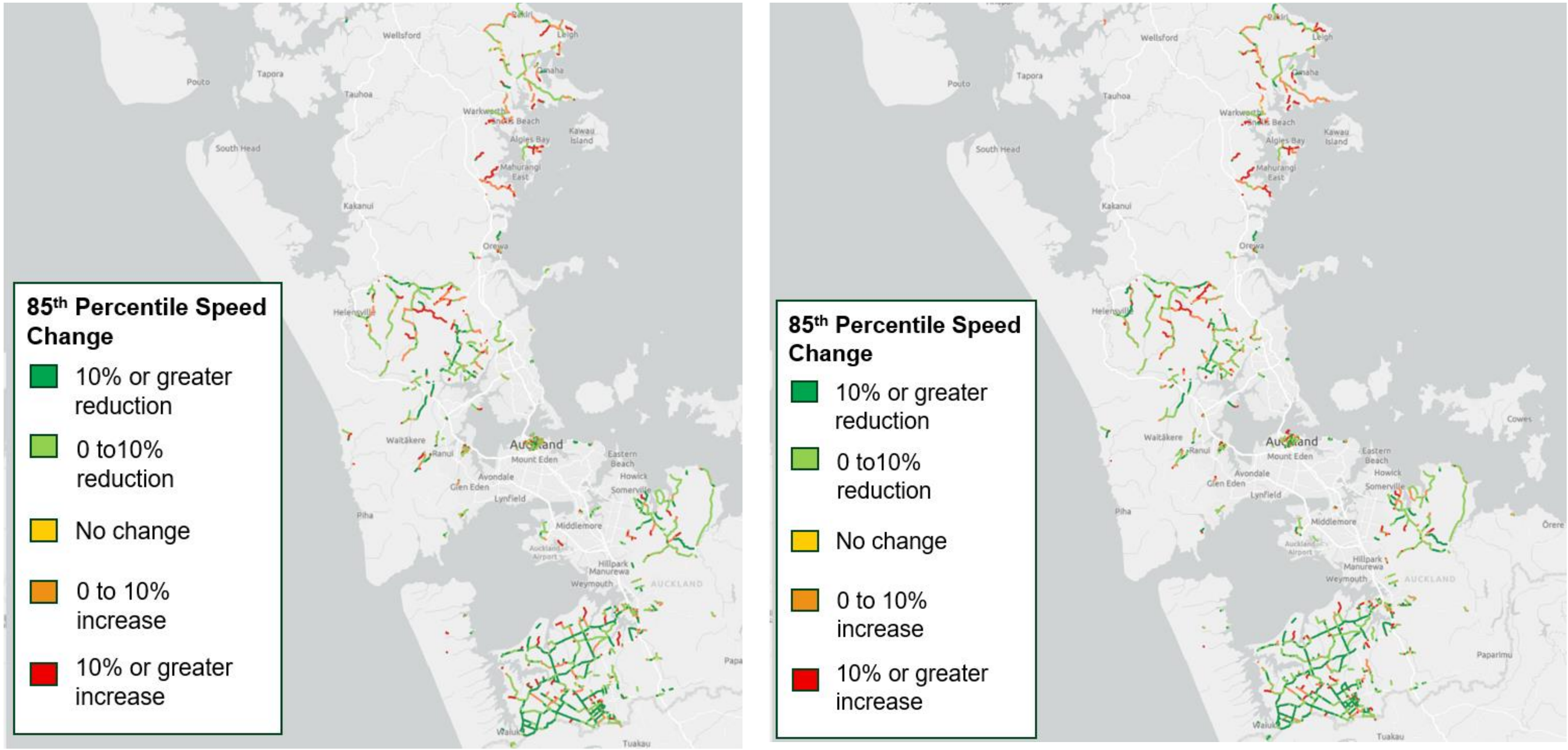

Figure D1.5 Phase 1 85th percentile change (All Auckland- left figure is direction 1 right figure is direction 2)

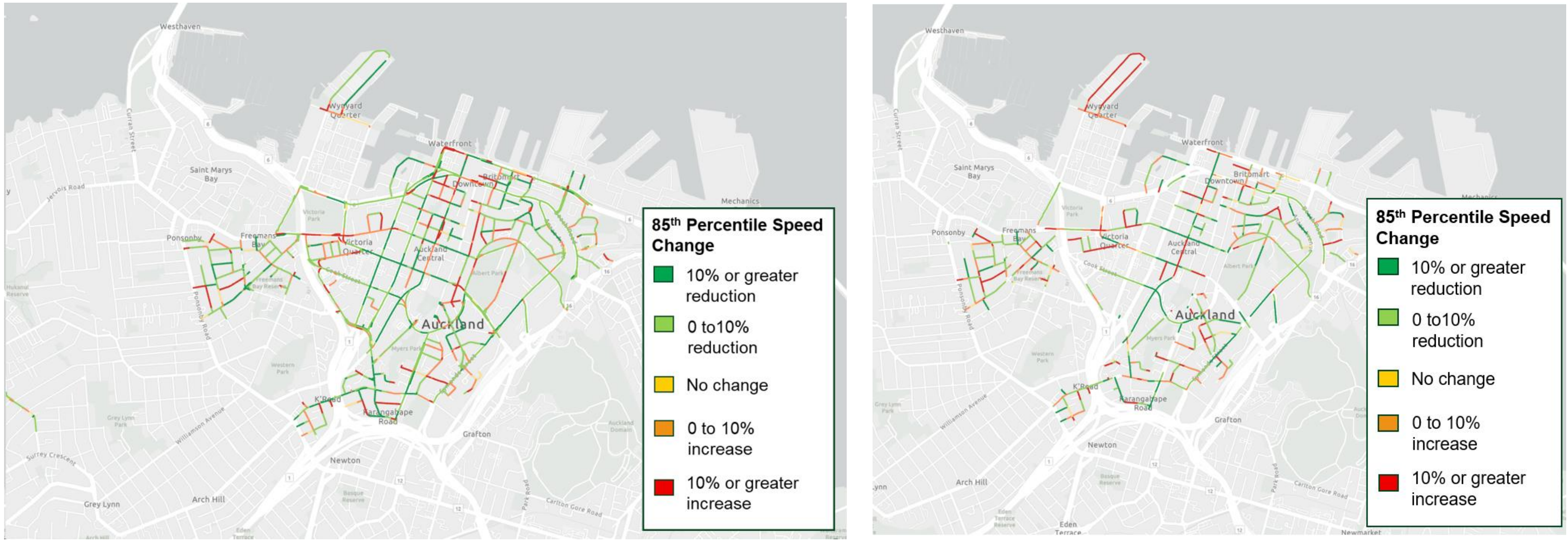

Figure D1.6 Phase 1 85th percentile change (City Centre- left figure is direction 1 right figure is direction 2)

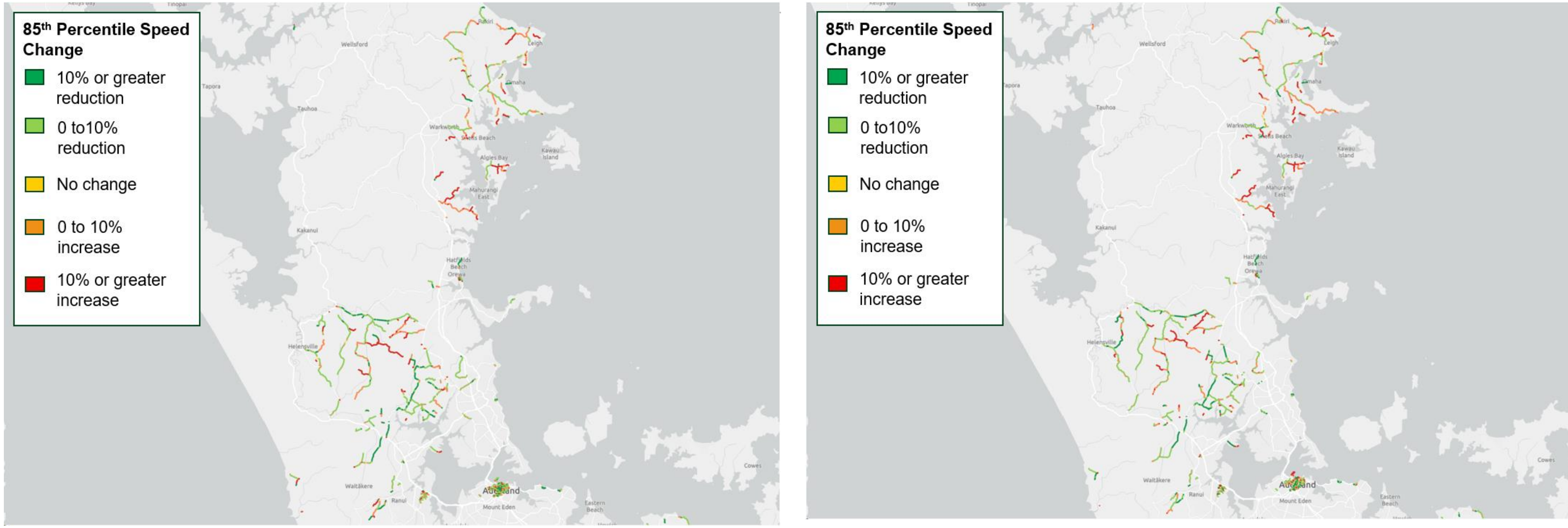

Figure D1.7 Phase 1 85th percentile change (North- left figure is direction 1 right figure is direction 2)

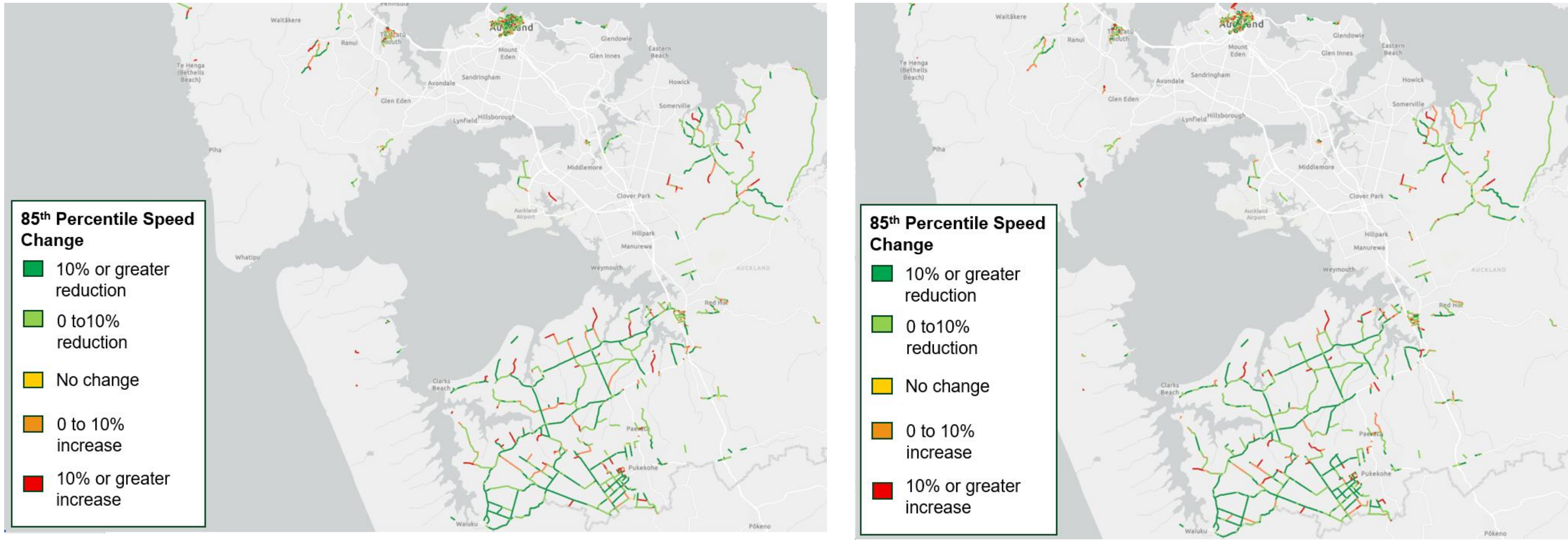

Figure D1.8 Phase 1,2 and 3 85 percentile change (South- left figure is direction 1 right figure is direction 2)

Appendix F.
Crash type analysis

F1. Crash type analysis

This analysis considers the numbers of crashes rather than the numbers of people injured. Injuries are used in the wider analysis.

Table F1.6 . Crash type analysis breakdown (Phase1)

Crash Type	DSI Crashes before	DSI Crashes after	% change
Head On Crash	9.2	8.1	-12%
Lost Cntl Bend	15.2	12.9	-15%
Lost Cntl/Str Rd	7.2	5.2	-28%
Manoeuvring	3.2	2.7	-16%
Merging	1.8	1.4	-22%
Misc	0.4	0.6	50%
Obstruction	0.6	0.9	50%
One Turns Right	4	3.5	-13%
Other Ped	1	2.3	130%
Overtaking	3.4	2.3	-32%
Ped Xing Road	10.4	7.5	-28%
Rear End Crash	1.8	0.9	-50%
Same Drn Turning	3.2	1.8	-44%
Xing Not Turning	2.4	2	-17%
Xing One Turning	5	2.6	-48%
Grand Total	68.8	54.7	-20%

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