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The Impact Of Change In Speed Limit At Three Sites

31 August 2022

wsp

150 YEARS IN AOTEAROA

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Revision Details

Revision	Details
1	Update crash data and added speed data of Karangahake Gorge
2	Removal of section of SH58 where barrier was installed

Contents

This report ('**Report**') has been prepared by WSP exclusively for Waka Kotahi ('**Client**') in relation to the impact of speed limit changes at three locations ('**Purpose**') and in accordance with the Waka Kotahi request from Maria Drinkwater dated 19 January 2021 to be undertaken in accordance with Embed Safe System-Vision Zero Approach and National Road Safety Strategy and Technical Support contract 2042 18 October 2019.

The findings in this Report are based on and are subject to the assumptions specified in the Report. WSP accepts no liability whatsoever for any reliance on or use of this Report, in whole or in part, for any use or purpose other than the Purpose or any use or reliance on the Report by any third party.

1 Introduction

This short report looks at the impact of three speed limit reductions:

1. SH2 Maramarua where the speed limit was reduced from 100 km/h to 90 km/h in December 2011
2. SH 2 Karangahake Gorge where the speed limit was reduced from 100 km/h to 80 km/h in 2005
3. SH 58 around Pauatahanui Harbour where the speed limit was reduced from 100 km/h to 80 km/h in 2005/6

In each case the analysis considers the impact on injury crash numbers, and the numbers of deaths and serious injuries (DSIs). The analysis also considers the rate at which the injury crashes and DSIs occur based on the estimated vehicle kilometre of travel on both the treated sections and a comparison section.

2 SH2 Maramarua

On 15 December 2011 the speed limit on sections of State Highway 2 between the SH1 Interchange and the SH25 Roundabout were lowered from 100 km/h to 90 km/h. The speed limit was lowered on sections A C D and E, as shown in Figure 1. However, the township of Maramarua remained at 70 km/h and the recently complete deviation, Section B remained at 100km/h.

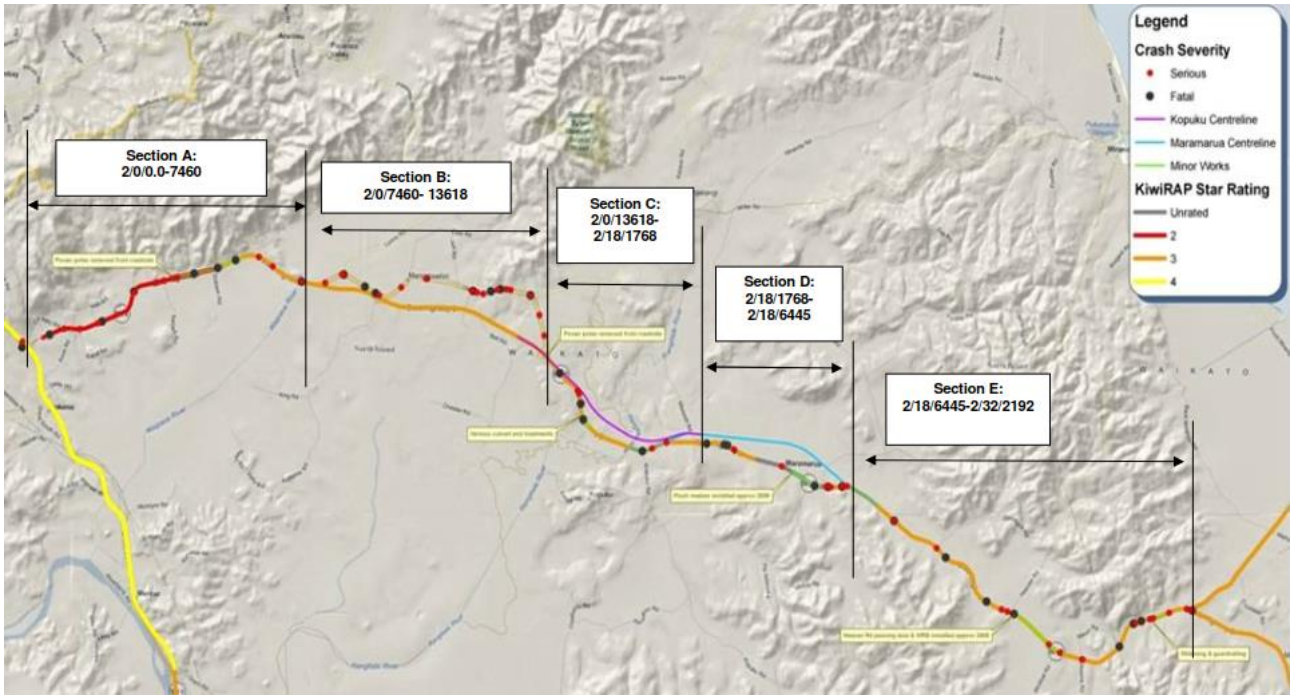


Figure 1 SH2 From SH1 to SH25

This investigation looks first at the impact of the change in speed limit on mean operating speeds, before looking at the impact of the change in speed limit on crash numbers, and finally looks at the crash rates before and after the speed limit change. The latter two analyses use an adjacent section of highway as comparison. One of the difficulties in choosing a suitable comparison section has been trying to minimise the impact of other safety works on the

comparison. In this case the comparison section covers the 100 km/h speed limit sections from SH2/SH25 Roundabout to Ngatea and the 100 km/h section from Ngatea to Paeroa. Although volumes drop at the SH25 intersection the comparison section carries a proportion of the same traffic as the Treated section.

2.1 Impact of Change in Speed Limit on Operating Speeds

The impact of the change in speed limit on the mean operating speeds of traffic is shown in Figure 2. A simple average of the speed changes suggests the 10 km/h reduction in speed limit resulted in almost a 9 km/h reduction in mean speed (from 95.4 km/h to 86.5 km/h). This was more than might ordinarily be expected as the research suggests a 3 to 5 km/h reduction in mean operating speed for each 10 km/h reduction in speed limit. [1] [2] [3]

It is also worth noting from Figure 2 that smaller but still significant speed reductions occurred in the two sections where the speed limit was not reduced suggesting a "spill over" of the calming effect.

Based on the re-evaluated Nilsson Power Model[4] a 9 km/h reduction in mean speed could be expected to result in a 28% reduction in reported injury crashes.

[1] Elvik R, Christensen, P & Amundsen, A 2004, Speed and road accidents: an evaluation of the power model, TOI report 740/2004, Institute of Transport Economics, Oslo, Norway.

2 Jurewicz, C. and Hall, K. 2009 Speed limit setting principles in the Safe System context Australasian Road Safety Research Policing and Education Conf Nov 2009 Sydney

[3] Jurewicz,C. and Turner, B. 2010 Infrastructure/Speed Limit Relationship in Relation to Road Safety Outcomes Austroads

[4] Cameron, M, & Elvik, R, 2008, 'Nilsson's Power Model connecting speed and road trauma: does it apply on urban roads?', Australasian Road Safety Research, Policing and Education Conference, 2008, Adelaide, South Australia, South Australia. Department for Transport, Energy and Infrastructure, Walkerville, South Australia,

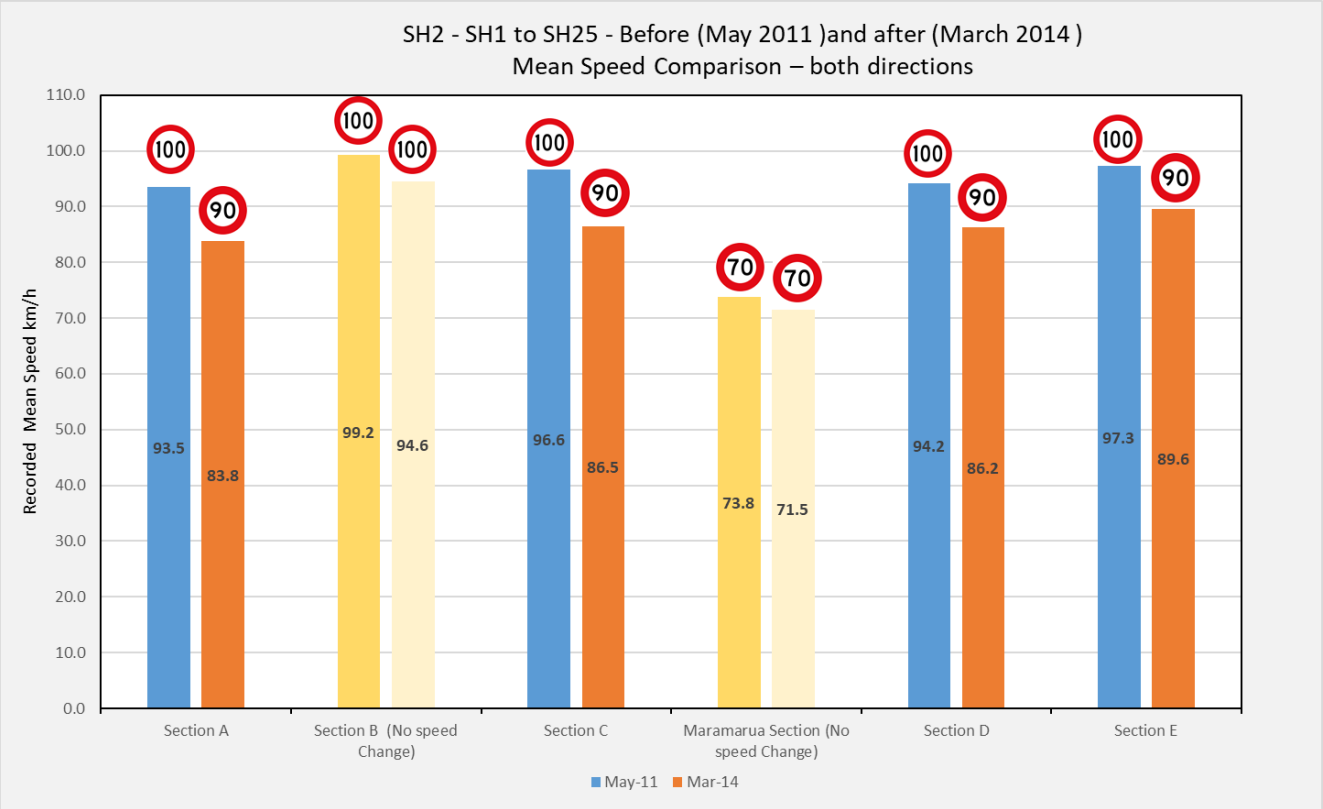


Figure 2 Before and After Mean Speeds on SH2 between SH1 and SH25 (note the series for the two sections where there was no change in speed limit are also May 2011 and March 2014)

2.2 Crash Occurrence

The crash analysis has considered two time periods the:

- 5 years before being 2007 to 2011 inclusive
- 5 years after 20012 to 2016 inclusive.

The analysis considers the impact on reported injury crashes and on the number of deaths and serious injuries that resulted.

2.2.1 Injury Crashes

There were a total of 68 reported injury crashes in the 5 years before the speed limit reduction, giving a 5 year average of 13.6 injury crashes per year. This reduced to 8 injury crashes per year or 40 reported injury crashes in the 5 years after; a reduction of 41.2% as shown in Figure 3.

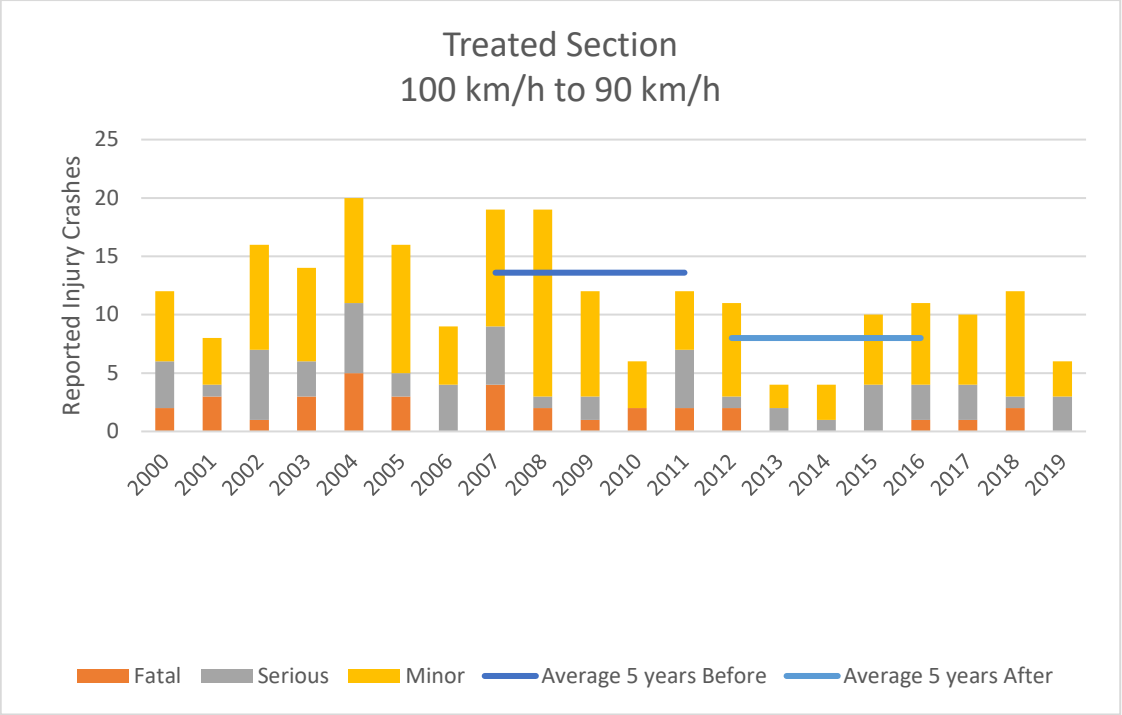


Figure 3 Injury Crashes on the Treated Section

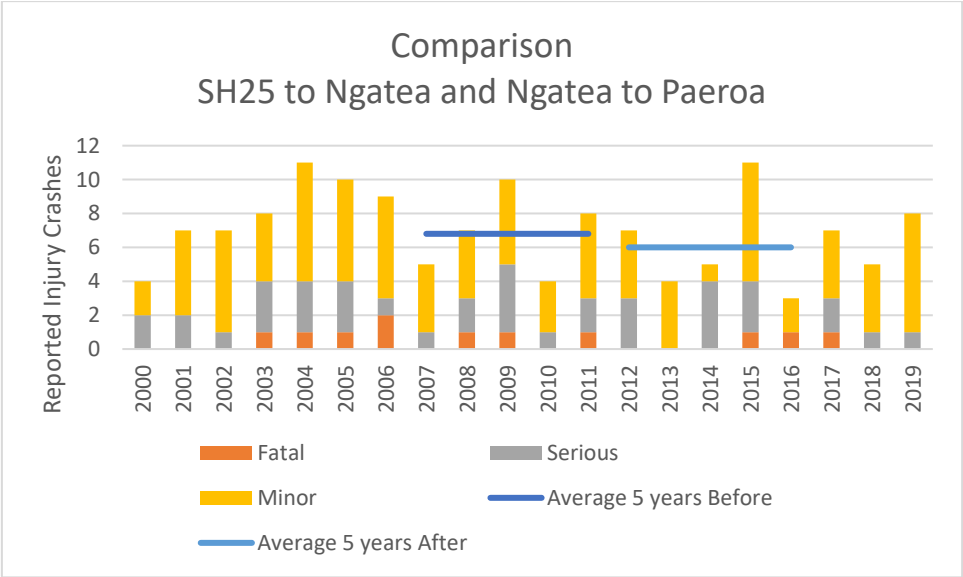


Figure 4 Injury Crashes at Comparison Site

Over the Comparison length, Figure 4, there were at total of 34 reported injury crashes reported in the 5 years before the speed limit was reduced at the Treated site dropping to 30 reported injury crashes in the after period a reduction of 11.8%.

The net for the Treated section is therefore 33% indicating a successful intervention.

2.2.2 Deaths and Serious Injuries

While the impact of the speed limit reduction on injury crash numbers is important, the expectation is that high severity crashes, those resulting in Death or Serious Injury (DSI) should show a greater reduction.

Figure 5 shows a 41.2% reduction in DSIs from 34 in the 5 years Before to 20 in the 5 years after at the treated site.

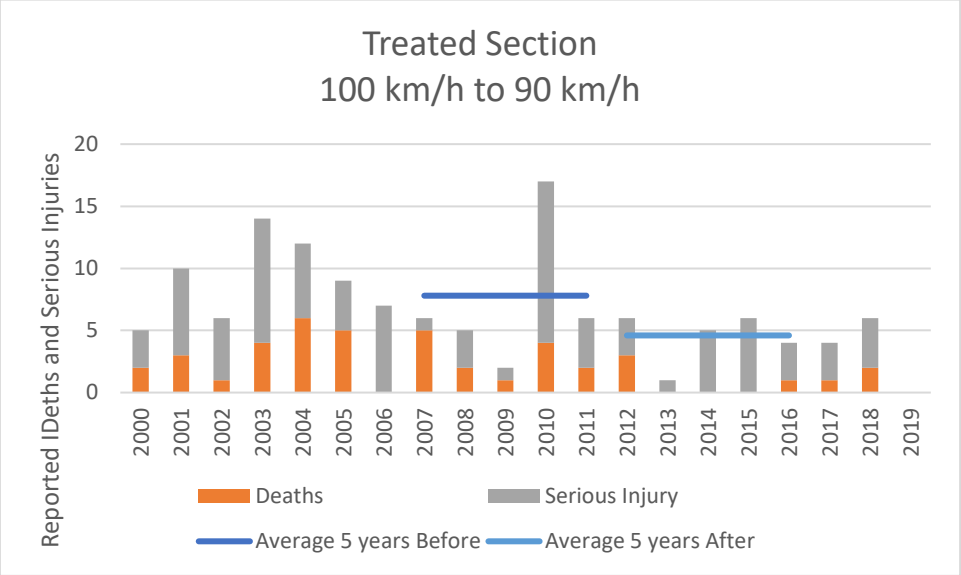


Figure 5 Deaths and Serious Injuries on Treated Section

At the Comparison site reported DSIs also decreased from an average of 3.6 per year for the 5 years Before treatment to 3.2 DSIs per year from the 5 years After, a reduction of 11.1%.

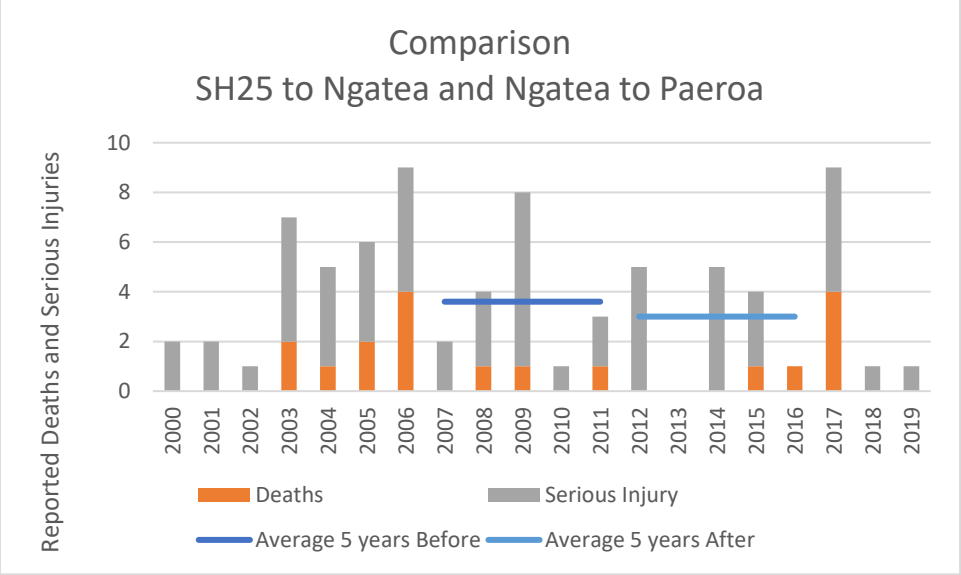


Figure 6 Deaths and Serious Injuries at Comparison Site

The net reduction in DSIs at the Treated site is therefore 36.1%, indicating a successful intervention

2.3 Crash Rate Analysis

While the preceding analysis has been based on crash numbers and the numbers of DSIs Before and After treatment the underlying assumption is that traffic volumes have remained similar across the two sites. However, while this is essentially true up until 2012 there has been a steady increase in Annual Average Daily Traffic (AADT) since then (Figure 7). This analysis looks at the rate of injury crashes or DSIs per 100 million vehicle kilometres of travel (VKT)

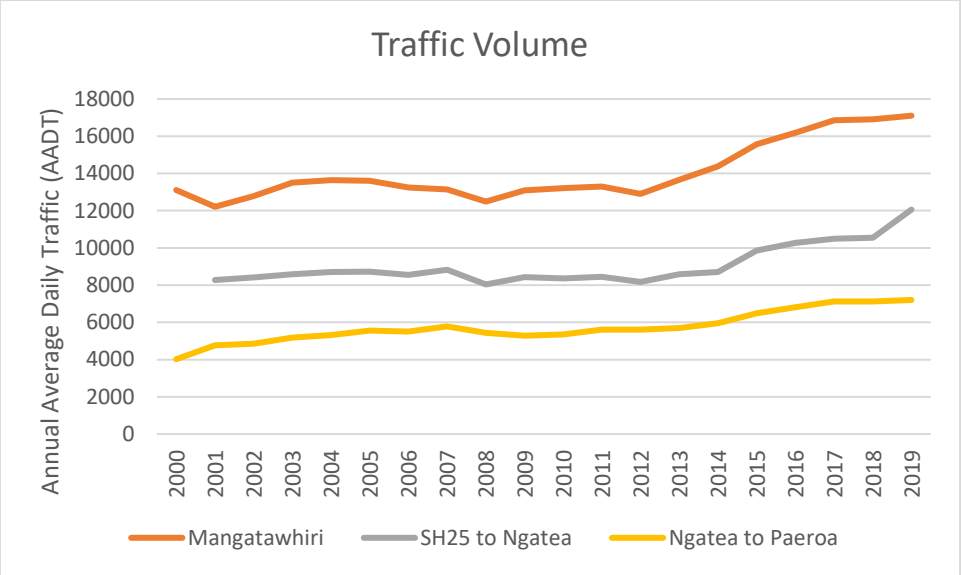


Figure 7 Traffic Volumes at Selected Locations on the Corridor

2.3.1 Injury Crash Rate

Looking at the injury crash rate for the Treated section, this reduced by 47% from a rate of 11.67 injury crashes per 100 million VKT Before the speed limit reduction to 6.16 injury crashes per 100million VKT After the speed limit reduction as shown in Figure 8.

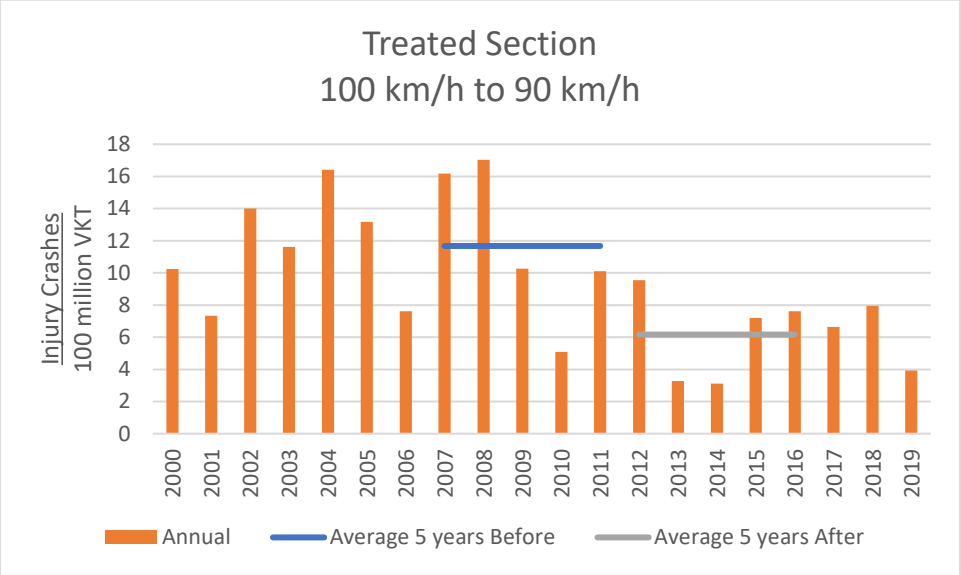


Figure 8 Injury Crash Rate on Treated Section

At Comparison there was also reduction in the mean injury crash rate from 10.38 to 9.22 injury crashes per 100 million VKT; an 11.2% reduction.

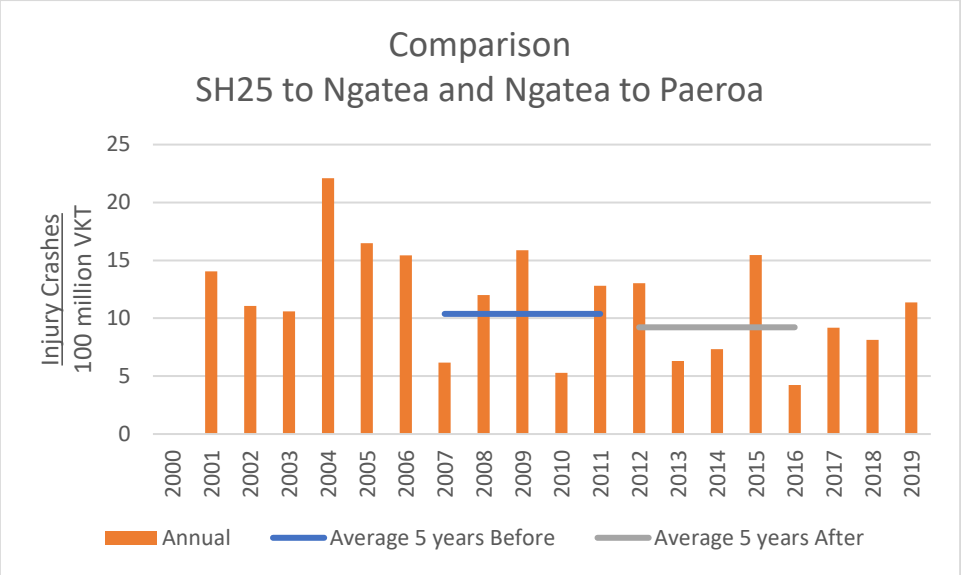


Figure 9 Injury Crash Rate at Comparison Site 2

In summary there has been a significant 47% reduction in the injury crashes per 100 million VKT at the treated site but the injury crash rate at the Comparison site reduced on 11.2%. This indicates a successful intervention. It is also worth noting that the net reduction of almost 36% is larger than the 29% reduction we might have expected given the change in speed and Nilsson's Power model.

2.3.2 Death and Serious Injury Crash Rate

At the treated sites the rate of death and serious injuries dropped from 6.69 to 3.54 deaths and serious injuries per 100 million VKT, Figure 10. This is a 47% reduction.

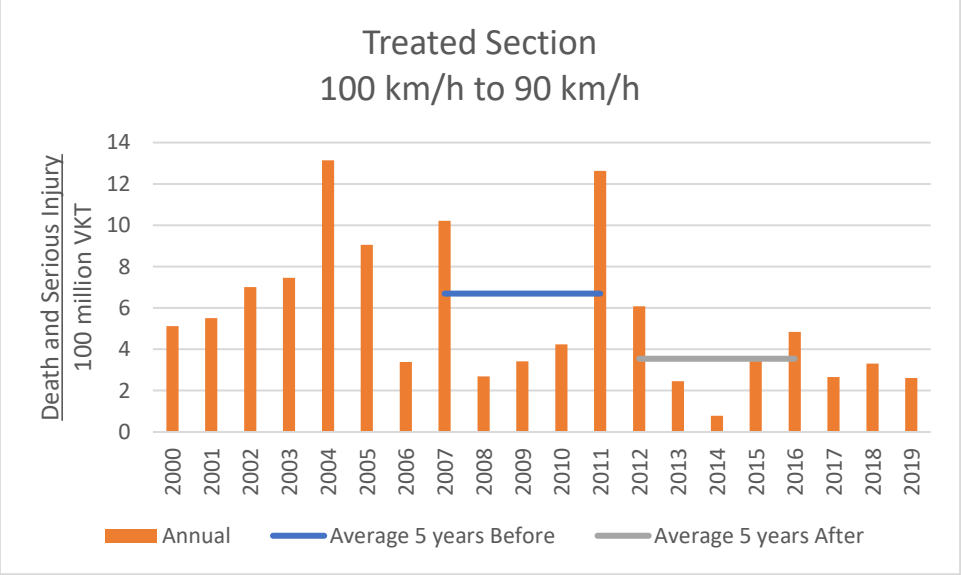


Figure 10 Death and Serious Injury Rate per 100 million VKT at Treated Site

At the Comparison site, Figure 11, there was a reduction of 8% from 6.2 DSIs per 100million VKT in the Before period to 5.7 DSI per 100 million VKT in the After period.

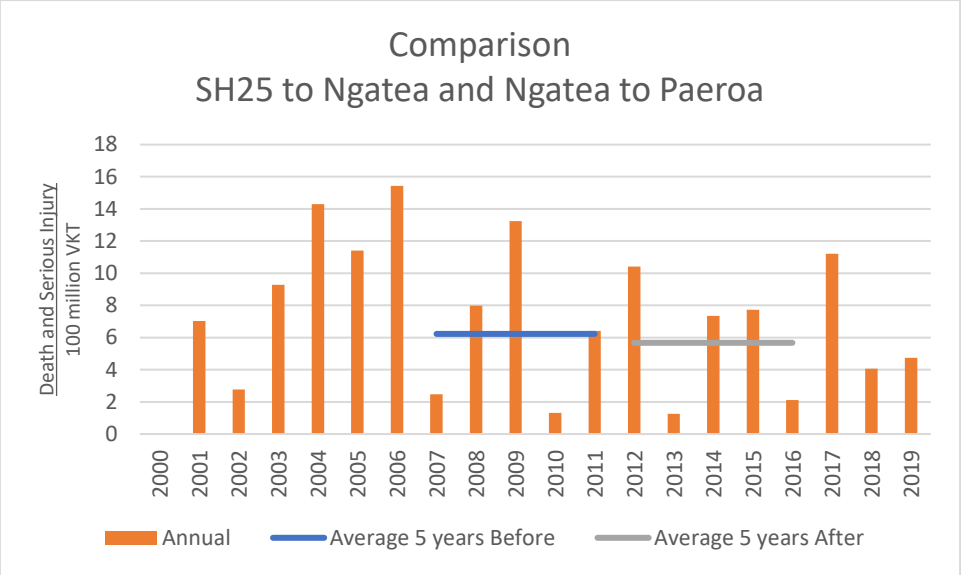


Figure 11 Death and Serious Injury Rate per 100 million VKT at Comparison Site 2

In summary the net reduction in the rate at which Deaths and Serious Injuries occurred at the Treated Site was 39%. This indicates a successful intervention.

2.4 Summary

In terms of the numbers of reported injury crashes and DSIs the treated site experienced a 41% reduction compared to an 11% to 12% reduction at the Comparison site. While the injury crash rate and the rate at which DSIs occurred saw a 47% reduction at the Treated site following treatment compared to a 9 to 11% reduction at the control sites.

This indicates that the intervention was successful when it comes to improving safety and could be expected to have saved 14 DSI in the first 5 years; with only a marginal increase in travel time of 95 seconds based on the change in average speed from 95.4 km/h to 86.5 km/h over the Treated section.

3 SH 2 Karangahake Gorge

On 30 November 2005 the speed limit in the winding Karangahake Gorge reduced from 100km/h to 80 km/h between RS 073/5.264 and 73/13.860; a length of 8.461km.

In an ideal world the best approach to this analysis would be to look at the relationship been the speed limit change and the change in operating speeds and then consider the impact on safety comparing the treated section with a comparison section which would be similar in all other aspects except the change in speed limit. However, data on the speed change is limited.

To further complicate matters it has been, it is quite difficult to find a suitable comparison section, or rather the detailed data to confirm that issues such as vehicle fleet, enforcement, improvements and maintenance items have not confounded the analysis. Such issues become increasingly likely as the time frames increase and as a result this analysis has focussed, in the main, on the 5 years before and after. For this analysis we have looked at the section of SH25 from Wāhi to Whangamata as the comparison.

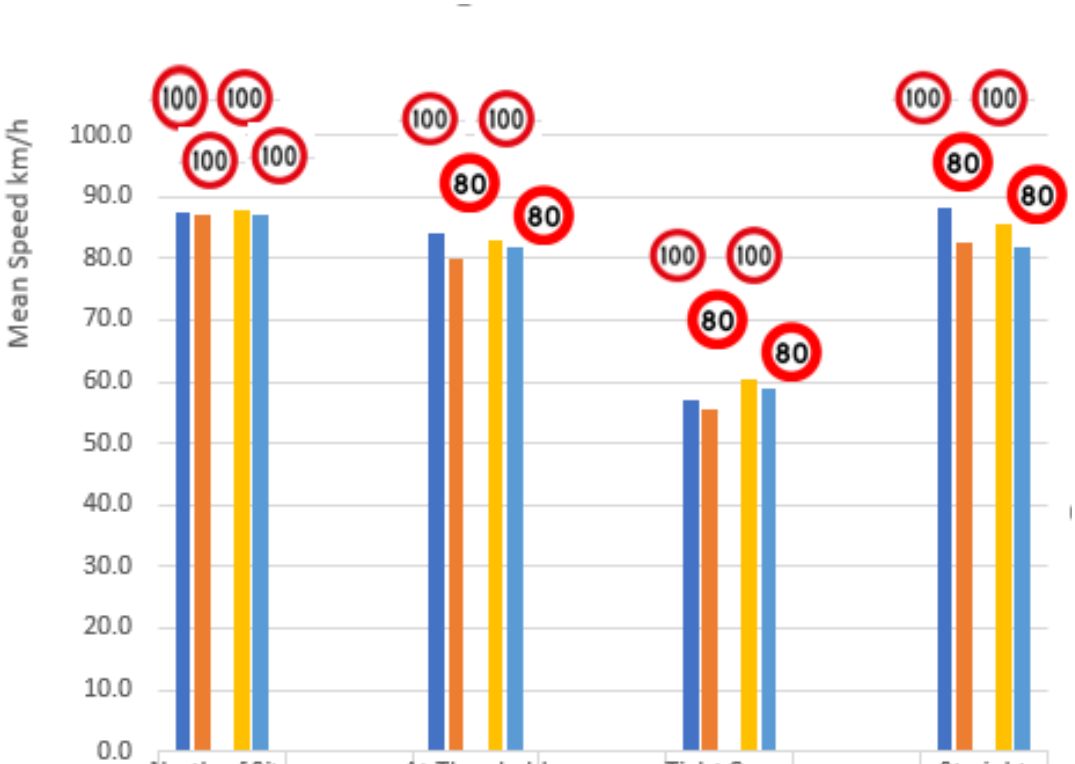
3.1 Impact of Change in Speed Limit on Operating Speeds

Before and After speed data has been collected at 4 locations; north of the site beyond the speed limit change, at the speed limit change threshold, on a tight curve within the reduced speed section and on a straight within the speed reduced area (see Figure 12).

To the north, outside the speed change area, there was no real change in speeds. At the threshold traffic exiting the reduced speed area were travelling on average 4 km/h slower while the speed of those entering the reduced speed area had dropped only around 1 km/h.

When negotiating one of the tight curves within the Gorge speeds were around 2 km/h slower following the speed change. However, speeds on the straight section 5.8 km/h and 3.7 km/h in the northbound and southbound directions respectively.

It is important to note that prior to the speed limit reduction speeds at all locations other than the tight curve were below 90 km/h and reduced between 2 km/h and 6 km/h.



	North of Site	At Threshold	Tight Curve	Straight
Northbound Before	87.4	83.9	57.2	88.4
Northbound After	87.0	79.8	55.4	82.6
Northbound After				
Southbound Before	88.0	82.9	60.5	85.7
Southbound After	87.1	81.8	58.8	82.0

Figure 12 Speed Changes in the Karagahake Gorge

3.2 Crash Occurrence

The crash analysis has considered two time periods the:

- 5 years before , 2001 to 2005 inclusive
- 5 years after, 2006 to 2010 inclusive .

The analysis looks to consider both all reported injury crashes and the deaths and serious injuries that result in.

3.2.1 Injury Crashes

Looking at the 5 years Before and After, Figure 13, the reported injury crashes reduced from an average of 6.6 reported injury crashes per year to 5.4 reported injury crashes per year a reduction of 18%.

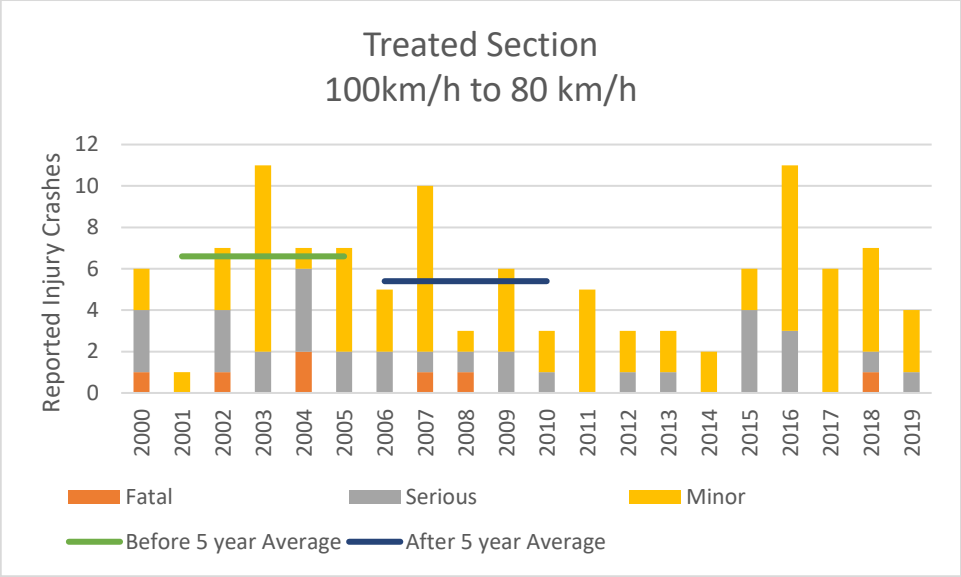


Figure 13 Injury Crashes Treated Section

For the same period injury crashes on the Comparison section increased from an average of 4.4 reported injury crashes per year to an average 5.4 reported injury crashes per year; an increase of 23%; Figure 14. This indicates a successful intervention.

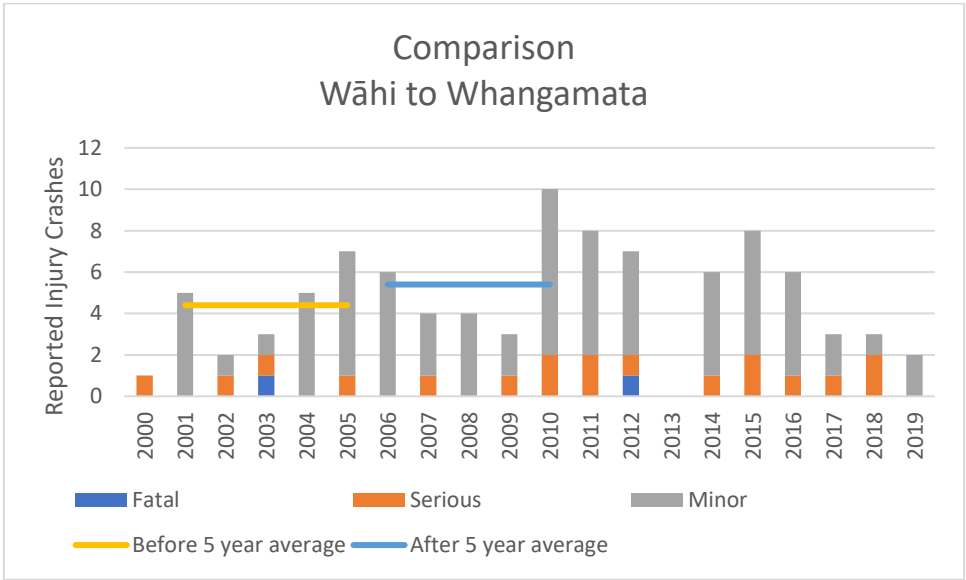


Figure 14 Injury Crashes Comparison Section

If we expect the comparison site to represent the overall trend, then the speed limit change in the Karangahake Gorge has resulted in a net reduction of 41% which is higher than what is expected based on international research[1,2,3].

3.2.2 Deaths and Serious Injuries

While an analysis of all injury crashes provides more data than looking at the high severity crashes, the objective of the speed limit reduction was to reduce the deaths and serious injuries occurring on the corridor. Looking at the 5 years Before and After, Figure 15, the Deaths and Serious Injuries (DSIs) dropped by a third (35%) at the treated site.

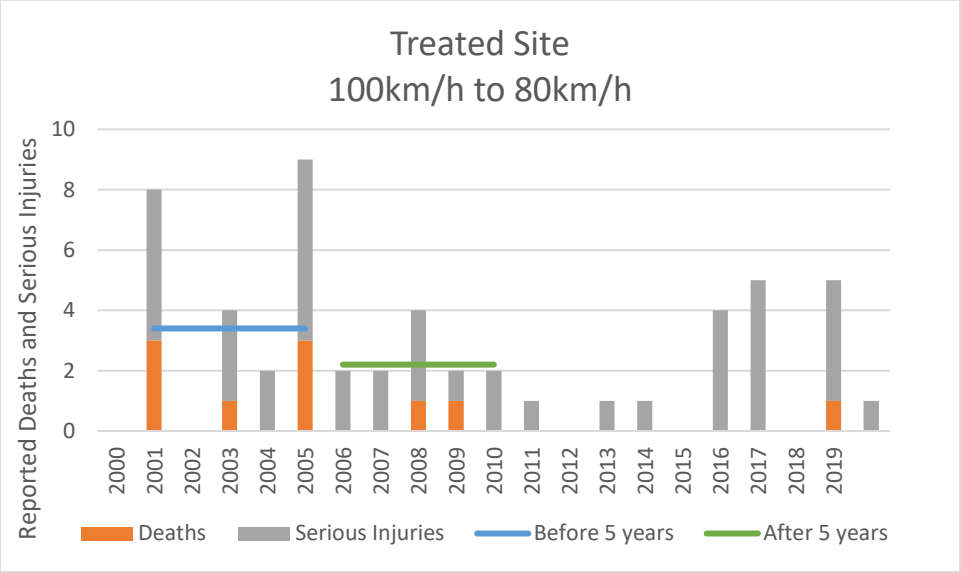


Figure 15 Impact of Speed Limit Reduction at Treated Site

In contrast Deaths and Serious Injuries at the Comparison, Figure 16, site increased by 25% in the 5 years immediately after the speed change. Although the numbers are low the net reduction was 60% Indicating a successful intervention.

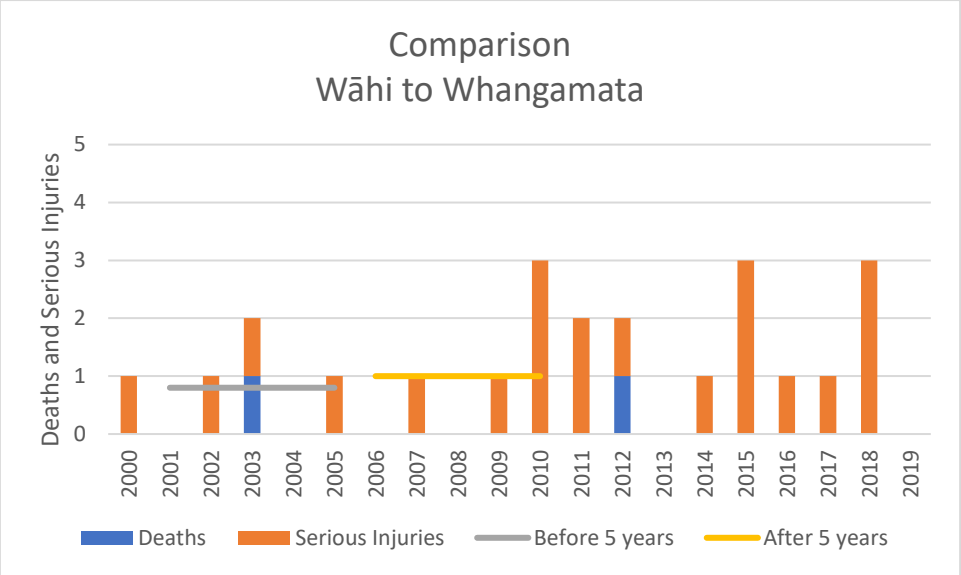


Figure 16 Deaths and Serious Injuries at the Comparison Site

3.3 Crash Rate Analysis

In addition to the before and after analysis using a comparison group it is possible to explicitly take account of traffic growth at the site, and comparison, over the analysis period using crash rate analysis, considering all reported injury crashes per 100million vehicle kilometre of travel or the Deaths and Serious Injuries that resulted per 100 million vehicle km of travel.

3.3.1 Injury Crash Rate

As with the crashes alone there has been a substantial reduction in the injury crash rate at the treated site when looking at the average over the 5 years before the speed limit reduction and the 5 years after the speed limit reduction, Figure 17.

In the case of the 5 year data the crash rate has dropped from 30.2 injury crashes per 100million VKT to 23.2 per 100 million VKT in the 5 years after; a reduction of 23%.

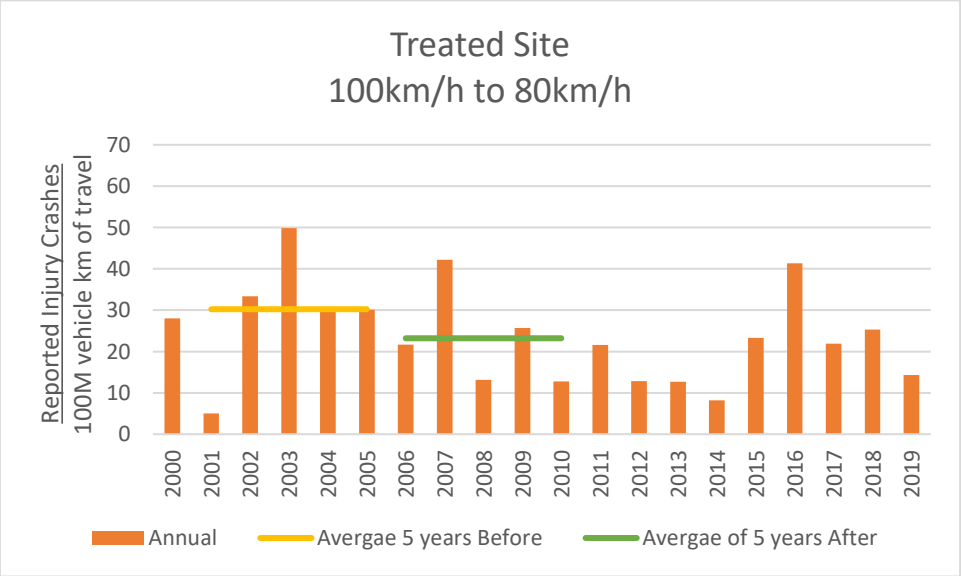


Figure 17 Injury Crash Rate At Treated Site

Over the same period, Figure 18, the Comparison site injury crash rate showed essentially no change dropping 3% from 21.5 injury crashes per 100 million vehicle km of travel to 20.8 reported injury crashes per 100 million VKT.

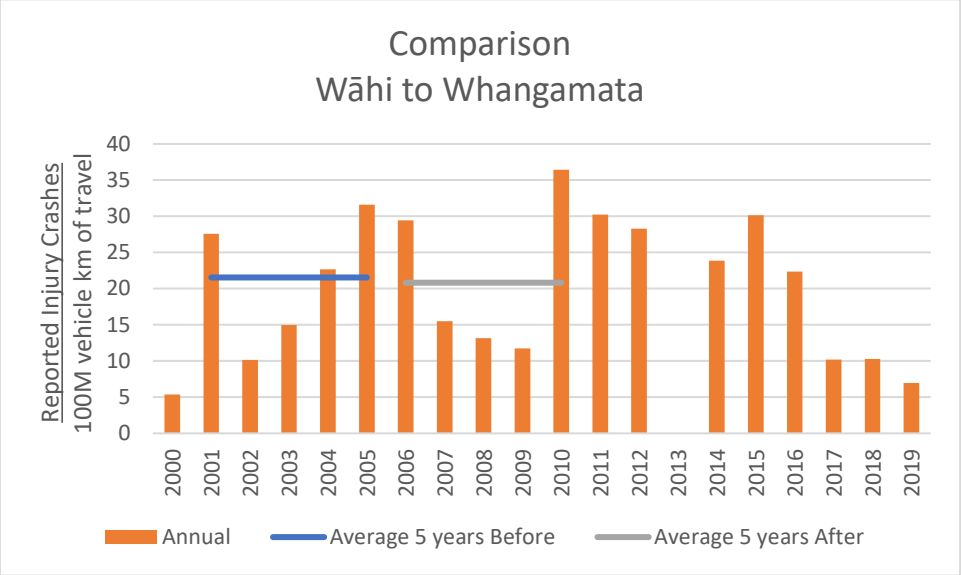


Figure 18 Injury Crash Rate at Comparison Site

This indicates a successful intervention.

3.3.2 Death and Serious Injury Rate

In terms of the rate of Deaths and Serious Injuries looking at the Treated site the average rate of death and serious injury for the 5 years Before (12.8 DSI per 100 million VKT) and 5 years After (7.7 DSI per 100 million VKT) result in a 40% reduction; Figure 19.

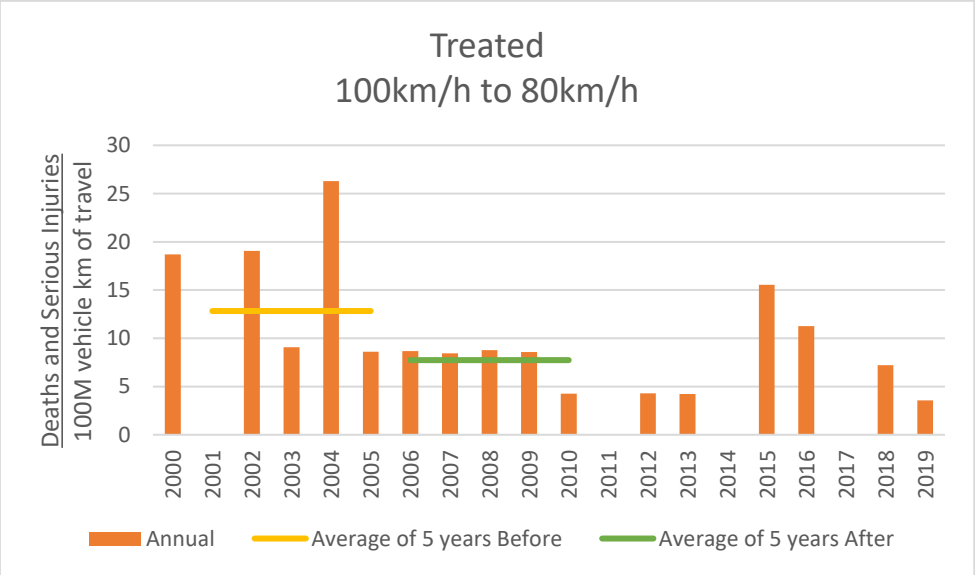


Figure 19 Death and Serious Injury Rate at Treated Site

However, the Comparison section the respective numbers are 3.92 dropping to 3.86 DSI per 100 million VKT a reduction of 1.6%.; suggesting no change; Figure 20

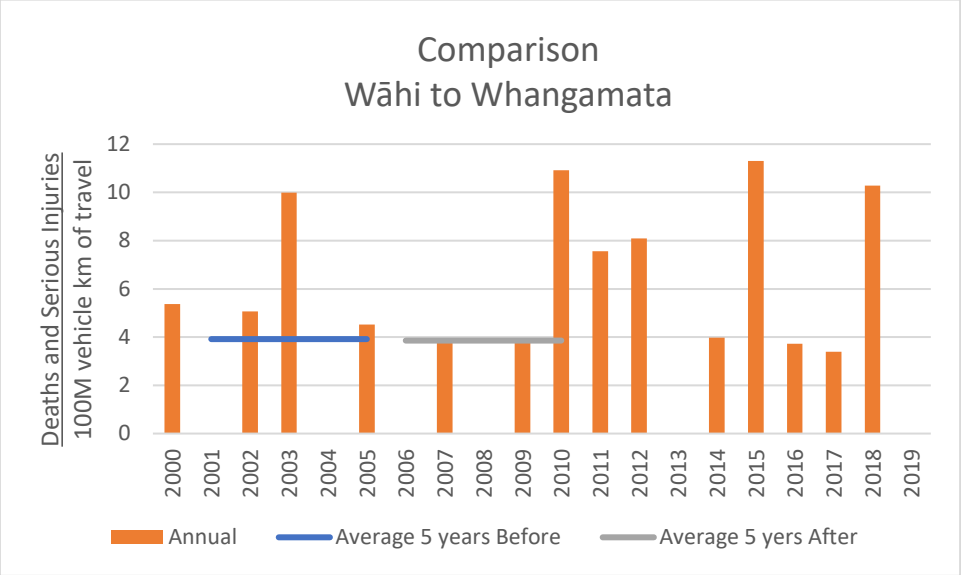


Figure 20 Rate of Death and Serious Injury at Comparison Site

The 40% reduction at the treated site compared with the 1.6% reduction at the comparison site suggests a successful intervention.

3.4 Summary

To summarise:

Speed at the gorge before the speed limit reduction were typically less than 90 km/h and the 20 km/h reduction in speed limit from 100km/h to 80 km/h has seen speeds decrease in the order of 2 km/h to 6 km/h suggesting the new speed limit is in keeping with the overall speed environment

Reported injury crashes reduced 18% at the Treated Site but increased by 23% at the Comparison Site

Deaths and Serious Injuries at the treated site reduced by 35% whereas at the Comparison sites they increased by 25%.

In terms of crash rate, the injury crash rate reduced 23% at the Treated site while the rate of Deaths and serious injury reduced 40% but there was no significant change at the Comparison site

The above indicates a successful intervention where the crash reductions have exceeded those expected.

The above savings amount to approximately 7 Deaths for Serious Injuries in 5 years. Against this is the increased travel time of 75 seconds. However, this is only theoretical being the difference between driving the Karangahake Gorge at the speed limit of 100 km/h or at 80 km/h.

4 SH 58 Paremata to Pautahanui

In 2005/6 the speed limit on the section of SH58 from Route Station 0 +9.772 to 13.129 was lowered from 100 km/h to 80 km/h. This is the section of SH58 that winds around the Pauatahanui Harbour and has numerous curves with advisory speeds less than 80 km/h.

While it would be useful to compare speeds before and after the speed limit change it has not been possible to locate any speed surveys from that time.

It should also be noted that when reviewing the crash data there are numerous instances where crashes are recorded as having different speed limits to those that were known to apply to that particular location at that time. In all cases crashes have been analysed based on the applicable speed limits.

The speed limits on the remaining sections, 1.5 km to the west remained at 50 km/h while the 9 km to the east remained at 100 km/h. It is the latter section which has been used as a comparison in the subsequent analysis. However, the initial 2 km have been excluded as a median barrier was installed during the analysis period.

4.1 Crash Occurrence

The crash analysis has considered two time periods the:

- 5 years before, 2001 to 2005 inclusive
- 5 years after, 2006 to 2010 inclusive.

The analysis looks to consider both all reported injury crashes and the deaths and serious injuries that result.

4.1.1 Injury Crashes

Looking at the Treated site there is essentially no change with injury crash numbers reducing only 4% before and after; Figure 21. This is in stark contrast to the Comparison site, Figure 22, where injury crashes increased by 47% from the 5 years before (21 injury crashes) to the 5 years after (31 injury crashes).

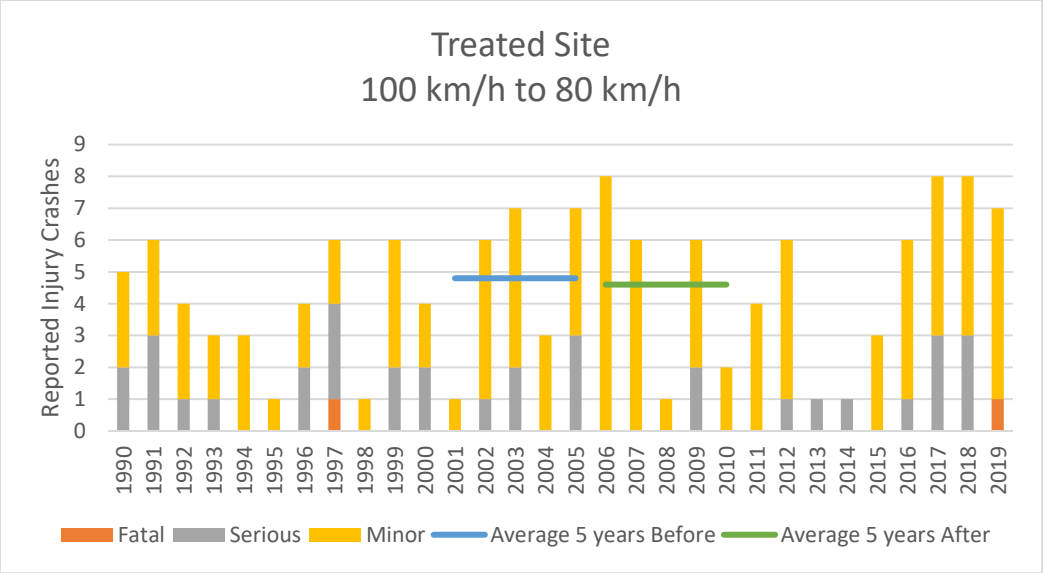


Figure 21 Injury Crashes at Treated Site

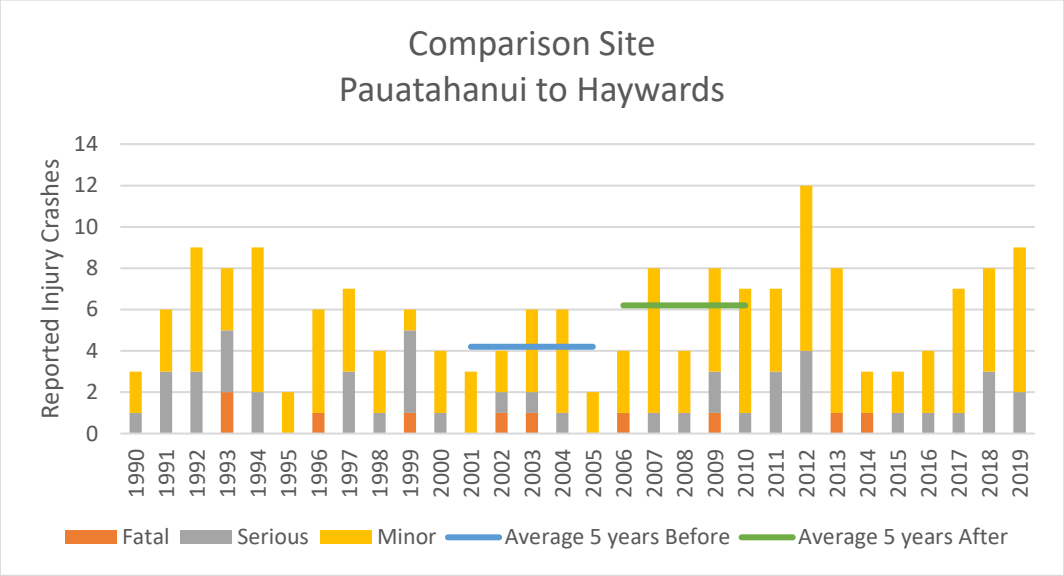


Figure 22 Injury Crashes at Comparison Site

4.1.2 Deaths and Serious Injury

Although the numbers are small the number of reported DSIs dropped from 7 (average 1.4) in the 5 years before to 2 (average 0.5) at the treated site. This 71% reduction suggests that while injury crashes remained essentially the same (Figure 21) crash severity had reduced dramatically

However, at the same time reported DSIs at the Comparison site dropped 12.5% from 8 DSIs in the 5 years Before (average 1.6) to 7 DSIs per year (average of 1.4) for the 5 years After; Figure 24..

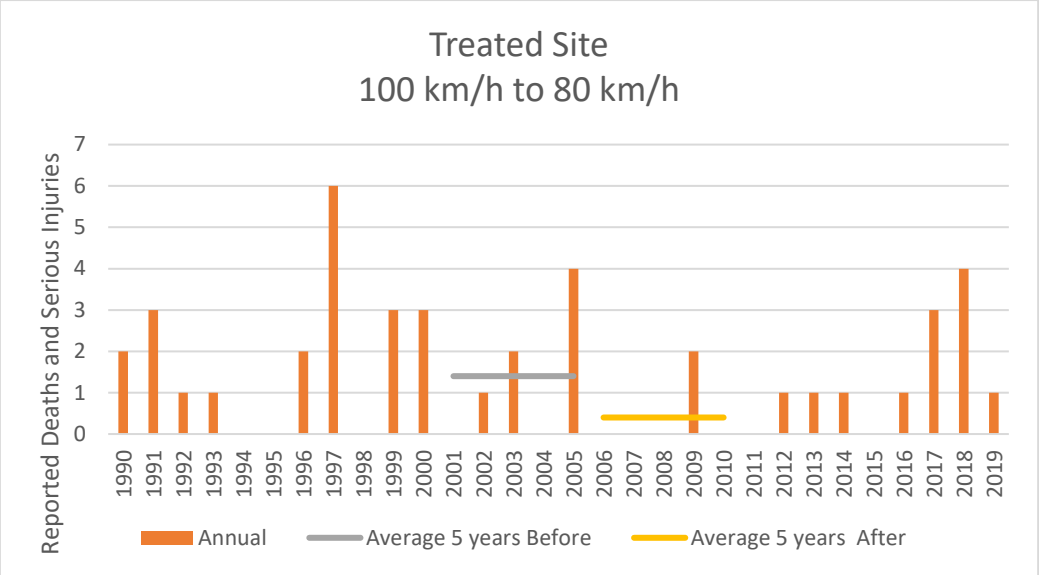


Figure 23 Death and Serious Injury at Treated Site.

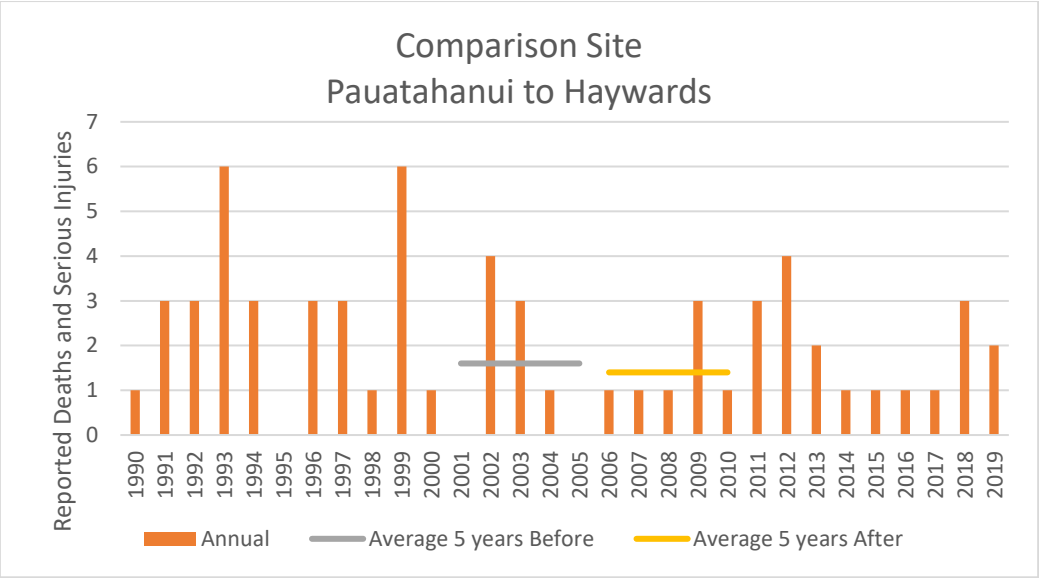


Figure 24 Death and Serious Injury at Comparison Site

The result is a net reduction of 58.5% at the Treated site, indicating a successful intervention.

4.2 Crash Rate

The crash picture for this corridor, the Treated Site and the Comparison is thought to be confounded by differential traffic growth along the corridor. For this reason, crash rate analysis is very important when assessing the impact of the speed limit change at this site.

4.2.1 Injury Crash Rate

Looking at Figure 25, the injury crash rate at the sites is high, and there is a marked reduction in injury crash rate following treatment. The injury crash rate drops some 35% from 61.4 injury crashes per 100 million VKT to 39.6.

However, at the Comparison Site, Figure 26, the injury crash rate increased 33.5% from 11.93 to 15.9 injury crashes per 100 million VKT.

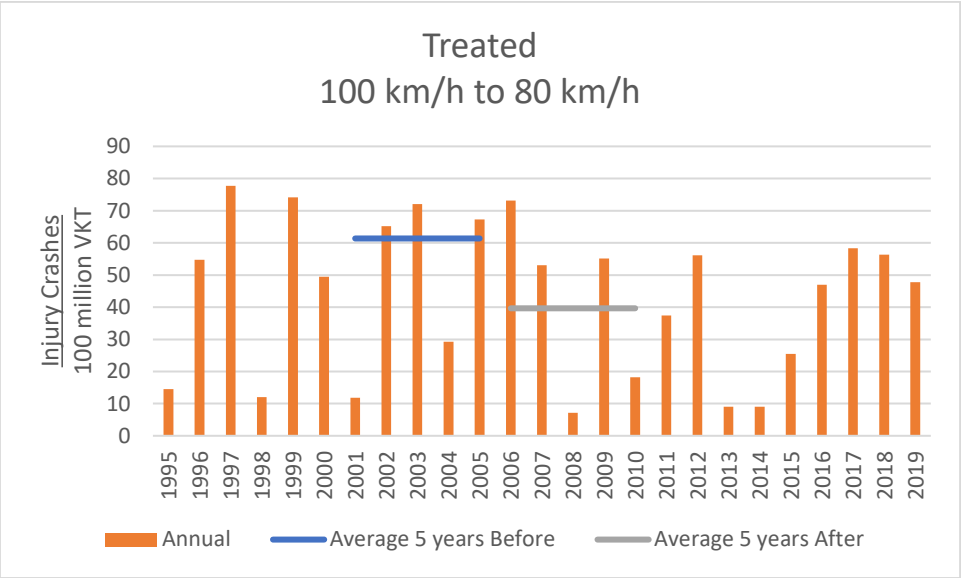


Figure 25 Injury Crash Rate at Treated Site

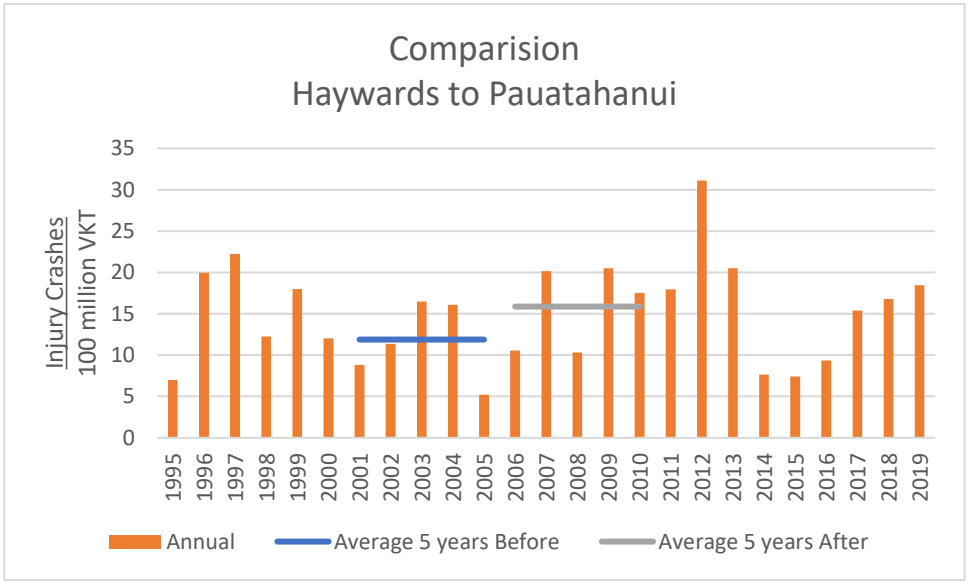


Figure 26 Injury Crash Rate at Comparison Site

Whereas the injury crash rate on the Comparison site increased the rate on the Treated site reduced with a net reduction of 68.5%. Indicating a successful intervention.

4.2.2 Rate of Death and Serious Injury

Once again, the numbers of DSIs are small and subject to fluctuation. However, the picture is one of reductions on both the Treated site and the Comparison site.

At the Treated site, Figure 27, the rate at which DSIs occurred dropped 75.1%. While at the Comparison site, Figure 28, the drop is only 26.3% suggesting a net reduction at the treated site of 48.8%. very similar to that for injury crashes.

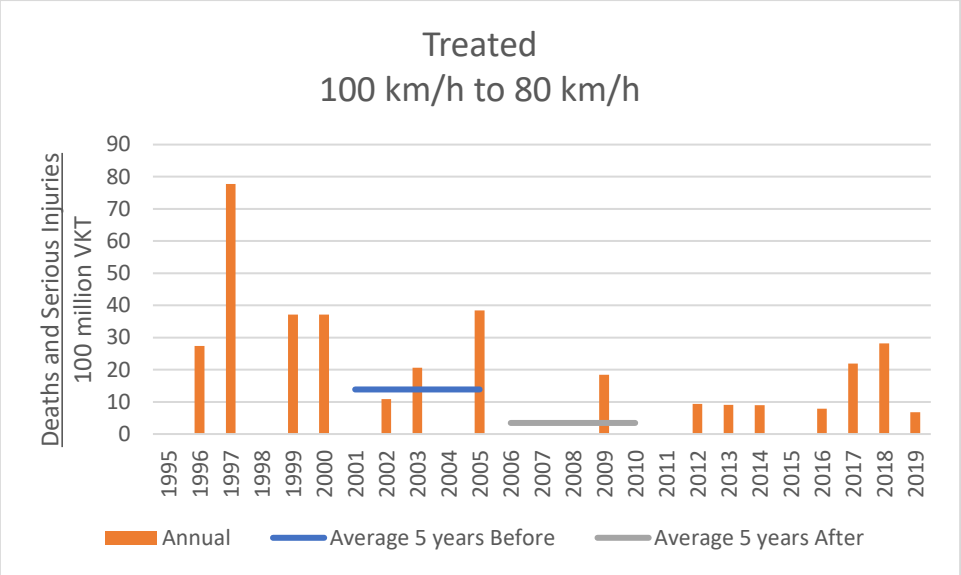


Figure 27 Rate of DSI at Treated Site

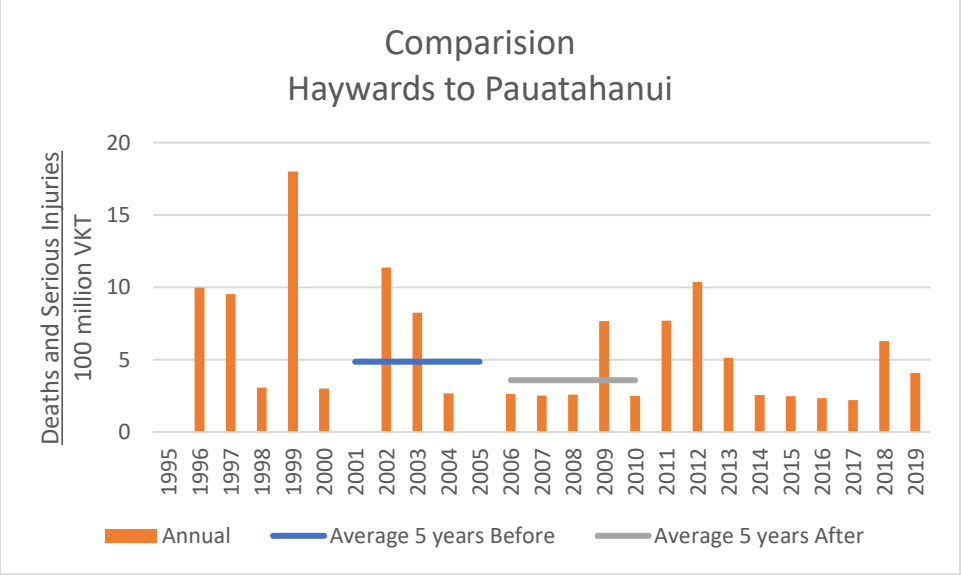


Figure 28 Rate of DSI at Comparison Site

4.3 Summary

Unfortunately, data on the actual speed reductions has not been located and the analysis has focussed only on the crash impacts. Although more variable than for the other corridors, the results from the Pauatahanui Corridor do indicate that the intervention has been successful in reducing injury crashes:

1. In terms of injury crash numbers there was a net 51% reduction in injury crashes and a 58.6% net reduction in DSIs when compared to the Comparison section
2. In terms of crash rates there was a net reduction of some 58.5% in the injury crash rate and a net 48.8% reduction in the DSI rate.

If it was possible to drive the treated section at 100 km/h and this was dropped to 80 km/h the maximum additional travel time would be some 30 seconds. This must be weighed up against saving on average 1.5 deaths or serious injuries every 5 years.

5 Summary

This report has investigated the road safety impacts associated with speed limit changes in three corridors. While data on the impact that the change in speed limit has had on operating speeds is limited a case comparison analysis has found crash reductions that are generally in keeping with or in excess of those documented in international literature.

The 10 km/h speed limit reduction at SH2 Maramarua resulted in a 9 km/h change in mean speed. At the other two sites SH2 Karangahake Gorge and SH58 Pauatahanui Harbour it has been suggested the operating speed change from the 20 km/h speed limit reduction would also be close to 9 km/h.

Although operating speeds were generally below 90 km/h, the 20 km/h speed reduction in speed limit through the Karangahake Gorge resulted in a 2 km/h speed reduction on tight curves and a 6 km/h reduction on straights.

In terms of the net reductions in injury crash and death and serious injury numbers Figure 29 (left), these are generally around or in excess of 30% which is what international literature would predict. The exception being Pauatahanui at just under 20%. This is most likely due to very low numbers involved.

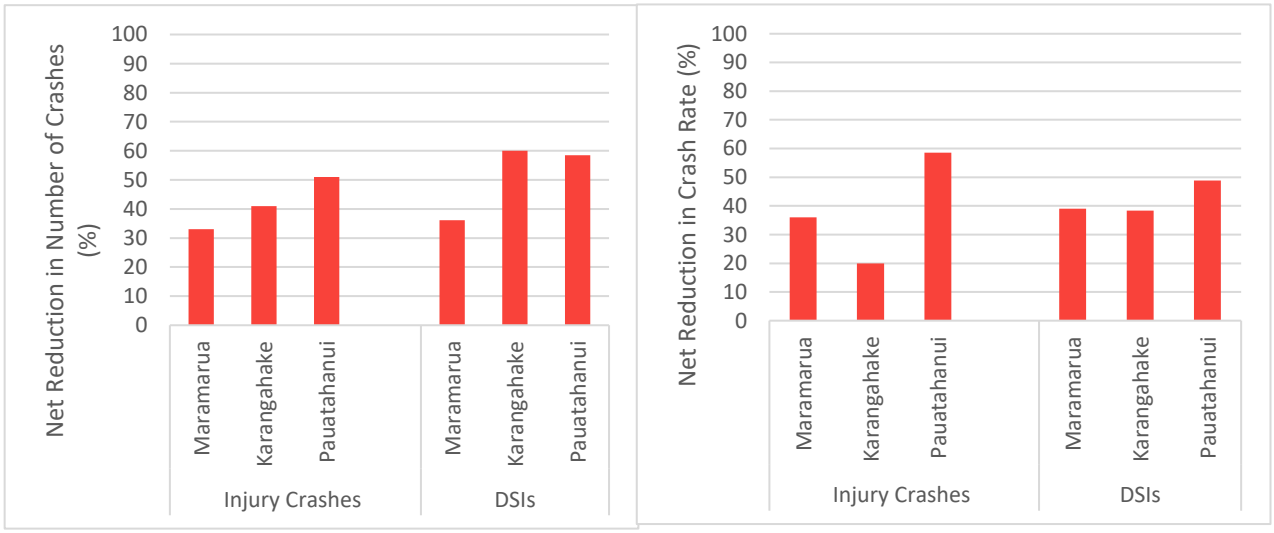


Figure 29 Net Reductions at Treated Sites Numbers (left) and rate per 100 million VKT (right)

The impact on injury crash rate and the rate at which Deaths or Serious Injuries occur, per 100 million VKT, is also in excess of international predictions.

This confirms the interventions were successful in terms of improving road user safety.