

25 August 2023

Kirstan O'Donoghue
 Principal Safety Engineer
 Waka Kotahi NZ Transport Agency

Dear Kirstan,

Re: Review of Economic Impact Analysis for SH5: Rangitaiki to Esk Valley

AECOM was engaged to review and provide commentary on the technical approach of the Economic Impact Analysis Report and supporting Peer Review for the speed limit reduction from 100 km/h to 80 km/h on State Highway 5 from Rangitaiki to Esk Valley. The report, completed by Ernst & Young (EY), provides an independent evaluation of the economic impact associated with the speed reduction, focusing on safety benefits, travel time costs and vehicle emissions benefits. Table 1 lists several key metrics that were determined from the analysis.

Table 1: Key Findings Reported in EY Economic Impact Report

	Metric	EY Values in Report
1	Avoided Crashes	34 average (high estimate 63, low estimate 5)
2	Average Value of Avoided Crash	\$936,319
3	Reduction in Cost due to Reduced Severity	\$3.26 million / per crash
4	Combined safety benefit per year	\$93 million
5	Weighted average of speed decreases	2.3 km/h

The peer review, completed by Ascari, provided several valuable comments about the analysis, but stated that overall, the report was a reliable, evidence-based assessment of the effects. Following our review by [REDACTED]

[REDACTED] AECOM has several comments on the validity of the presented approach, which may have significant impacts on the reported findings, summarised as follows.

1. Lack of consideration of the impact of safety improvements on collision reductions:

The report noted that safety investments were completed on SH5, including side barriers and road marking improvements; however, no consideration was made in the analysis to isolate the effect that this would have on safety benefits, regardless of speed limit changes. The High-Risk Rural Road Guide states that side barriers have a 45% reduction in run-off-road injury crashes and a 40% reduction in total crashes.

The news website Stuff¹ indicates that \$2.5M of safety improvements were to be constructed on the corridor covering the interventions above as well as the installation of Audio Tactile Profiled markings.

Reference to the improvements was raised in the peer review, and we agree that this is a critical consideration impacting the analysis, possibly resulting in overly inflated safety benefit numbers from the speed limit reduction.

¹ <https://www.stuff.co.nz/national/125579424/planning-for-100m-safety-upgrade-on-notorious-napiertaup-road-being-brought-forward>

- 2. Oversight of the significant impact that regression-to-the-mean has on pre/post crash data analysis:** Regression-to-the-mean effect is a statistical phenomenon important in crash data analysis. Due to this effect, roads with a high number of crashes in a particular period are likely to have fewer during the following period, even if no measures are taken. In simpler terms, it explains a natural fluctuation in crash data year over year and its impact has been found to distort comparisons between before-after crash data to a significant extent.

To put this in context for the corridor of study, one crash on SH5 in 2020 resulted in 12 DSIs, making up for nearly 45% of the DSIs that year. The next year, there were only 2 DSIs on the same section of SH5, which is a significant reduction despite no changes being made. It appears that the analysts attempted to account for regression-to-the-mean by looking at the decrease in crashes before/after the speed limit year over year (see Metric 1 in Table 1). It perhaps would have been more suitable to report the lowest change and use that for subsequent analysis to avoid an artificial inflation of benefits.

In general, the MBCM states that “for the purpose of crash analysis, generally a minimum of the past five years of reported crash history is used. This reduces the error caused by regression to the mean.” Given the relatively short period of time since the changes, it is suggested that a minimum of 3 years of crash data is needed to avoid regression to the mean and provide a robust and statistically valid comparison. However, observations of the performance of the safety measures immediately after implementation is still useful and should continue to be monitored.

Additionally, based on a quick review of CAS data along the corridor, it is not clear how the change of crashes data listed in Metric 1, Table 1 were obtained. A maximum change of 63 crashes appears high. More data supporting the expected reduction in crashes and explanation of why an average of 34 is an appropriate estimate would increase the validity of the approach, as this number is foundational for subsequent analysis.

As suggested in the Peer Review, AECOM agrees that a comparison of the crash data for the same time periods should have been reported for the section of roadway on SH5 that did not have a speed limit reduction. This would have provided some indication of the natural annual variation in crash data along the same corridor.

- 3. Concern with the average value of crash calculation:** It is not clear how the analysts determined the average value of a crash of \$936,319. More detail about this calculation and supporting data would be valuable because this value is foundational for subsequent analysis.
- 4. Model assumptions for the reduction in severity of crashes due to speed limit changes:** The validity of the econometric model to determine the Marginal Effect of a 1 km/h change in speed limit on injury severity is difficult to assess without more information. Details of the model should be provided. In general, a model Adjusted $r^2 = 0.18$ is very poor and is perhaps not reliable enough to base definitive economic conclusions on.

In addition, it does not seem appropriate that the 1 km/h benefit forms a linear relationship (i.e., can be multiplied by 20 for comparison of 80 km/h to 100 km/h posted speeds), especially given what research has shown on the exponential nature of injury-severity curves. This model and linear relationship assumption is used to determine the average reduction in cost due to reduced speeds- the \$3.26 million metric provided in Table 1. It is recommended that the model assumptions are reviewed as it is used to estimate \$62.9 million in annual savings, which may not be an accurate representation.

The report also states on Page 14 that the “total number of vehicles is the single most important decider in determining the severity crash.” This statement should be re-phrased, as AADT is not tied to severity outcomes, whereas speed is tied to severity outcomes.

- 5. Concern with the Reliability of Speed Data:** The speed data was used to provide estimates on the change in operating speeds and impact on journey times before and after the posted speed limit change. Figure 2 in the EY report displays the estimated crash speeds from CAS, which is not an accurate representation of speeds and differs from the distributions in Figure 3. Using the presented MegaMaps data, the average speeds were found to decrease by approximately 2km/h, although only 2023 data was available, which has a shorter reporting period (Metric 5 in Table 1).

Further commentary should be provided on natural fluctuations in the speeds with time. Analysis completed by Waka Kotahi with Tomtom data from 2019 and 2020 showed fluctuations in mean speed prior to the speed limit (~0.5-2 km/h depending on the segment). In general, the speed changes presented in the report could be within the margin of error/natural fluctuations on the road. However, AECOM notes that there are limitations in the available speed data and recognises EY's efforts in presenting ranges in the subsequent economic assessments.

It would have provided some interesting insight to look at the available data on the section of SH5 that did not have a speed limit reduction to compare to the reduced speed section over the same time periods.

- 6. Lack of commentary on or quantification of the influence of confounding variables:** The analysis relied on the available crash and speed data collected over a multi-year period but did not provide commentary or potential quantification of how other confounding variables may have influenced the input data. It was stated that COVID data was removed from the reduction in severity portion of the analysis but was included in the probability distribution for crashes. Other effects that may have influenced the data was construction work to install barriers and complete other safety improvements, possible temporary speed limits, level of enforcement and education efforts.

Enforcement and education efforts were completed along SH5 in 2022 to provide a more holistic approach to improving safety, this included an increase in police interactions by 417% compared to the previous year, multiple safety billboards and electronic signs². The impact of these confounding factors was not commented on in the analysis.

- 7. Underestimation of the % of Heavy Vehicles in the Vehicle Operating Costs and Emissions Section:** The underestimation of the % of heavy commercial vehicles (EY used 6.1% instead of 17.3% from Traffic Monitoring Site Data in the area) was listed in the Peer Review but it also stated that this was unlikely to influence the results of the assessment. AECOM agrees that the HCV% does not influence the travel time impact according to MBCM 1.6. The Composite Values of Travel Time for all periods on rural strategic roads should be confirmed (Table 17 of the EY Report) and assumptions referenced if a 2023 update factor was applied.

For the emissions calculations, Heavy vehicles produce ~3x more CO₂-e compared to light vehicles, therefore the underrepresentation of heavy vehicles does impact this estimate. This should be reviewed, as it may have a more significant effect on the analysis after the safety benefits are reviewed following the commentary above.

- 8. Alignment of the findings with international research:** Research undertaken internationally to review the impacts of speed limit changes on safety have found that broadly a 1% reduction in mean speed typically leads to a 4% reduction in fatal crashes, a 3% reduction in serious injury crashes and a 2% reduction in minor injury crashes. Research undertaken for Waka Kotahi by WSP³ on speed limit changes at three locations in New Zealand, found the

² <https://www.stuff.co.nz/national/125592557/no-fatal-accidents-since-launch-of--stay-alive-on-5-campaign-on-napiertaup-road>

³ <https://www.nzta.govt.nz/assets/resources/speed-management-guide-road-to-zero-edition/wsp-the-impact-of-change-in-speed-limit-of-three-sites-report.pdf>

reductions at these sites aligned with what would have been predicted from international literature.

Noting the discussion above on the accuracy of the reduction in mean speed, a reduction in mean speed from 88km/h to 86km/h would equate to a 2.3% reduction in mean speed. Research suggests this would result in approximately a 9% reduction in fatal crashes, a 7% reduction in serious injury crashes and a 5% reduction in minor injury crashes. The EY report has a mean number of total crashes before the change of 59 crashes per year and 25 after. This provides a 58% reduction in total crashes. Although this includes all crashes and not just injury and fatality crashes, this reduction is well outside what would be expected from a mean speed change of 2km/h, reinforcing the likelihood that the regression to mean effect and other factors outside of the speed change may be impacting crash numbers.

9. **Missing references:** Several sections in the report cite literature or present statistics; however, no references are provided. The report would be strengthened with the inclusion of a reference section.
10. **Response to Peer Review Comments:** AECOM agrees with several of the comments and questions raised in the peer review; however, it does not seem that these were addressed in the final version of the EY report. Several clarifications were requested, reformatting of the data to improve reader comprehension, additional analysis on the SH5 section of road that had no speed limit reduction, and quantification of the impact due to safety interventions are a few of the comments that should have been addressed.

There are several concerns with the Economic Analysis that could have significant impacts on the reported benefits related to the speed limit reduction on SH5 from Rangitaiki to Esk Valley and AECOM recommends a subsequent review of the findings to confirm the validity of the results.

Please feel free to contact us if any further explanation is needed.

Yours Sincerely,



AECOM New Zealand