flow TRANSPORTATION SPECIALISTS

# technical note

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| **PROJECT** | **NETWORK DISRUPTION COST OF SERIOUS CRASHES** |
| **TO** | **IVY HAO, PING SIM, AUCKLAND TRANSPORT** |
| **FROM** | PHIL HARRISON |
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| **DATE** | 18 JULY 2025 |

## 1. SUMMARY


The 2024 Government Policy Statement on Transport (GPS) emphasises that the Government's overarching priority is to support economic growth and productivity. A critical element of the transport system's productivity is the predictability and reliability of journey times.

Safety is an inherent part of productivity, and one of the most disruptive and unpredictable events that can have a major impact on the operation of the road network is a serious crash. This study sought to quantify the network disruption due to serious crashes in Auckland and to attribute a cost to the resulting additional delays to road users.

This small scale pilot research study examined recorded travel times on road links around 4 serious crash sites to identify where it is likely that the crash and resulting lane or road closures caused additional delays on the road network.

The estimated quantum of delays due to the four crashes and their estimated cost, including an unexpected disruption factor, are summarised below. Note that this does not account for all the costs that may be incurred, such as increased vehicle operating costs, or the cost of cancelled or deferred trips. As such, these figures are recognised to underestimate the total costs of the network disruption.

| Crash # | Crash Type | Duration of Congestion | **Estimated # of Vehicles Delayed** | **Estimated Average Delay** per vehicle | **Estimated Maximum Delay** | **Estimated Maximum Cost of Delay** per vehicle | Total Delay (vehicle hours) | Total Unexpected Delay Cost |
|---|---|---|---|---|---|---|---|---|
| **1** | Motorway Multi Vehicle | 6 hours | 20,000 | 30 mins | 3 hours | $450-$650 | 9,120-16,320* | $1,420,000-$3,500,000* |
| **2** | Divided Arterial 2 Car | 2.5 hours | 4,500* | 2.5 mins | 10 mins | $24-$35 | 179** | $25,800-$37,400** |
| **3** | 4 Lane Arterial Car v M/cycle | 1 hour | 3,700 | 2.3 mins | 5.5 mins | $14-$20 | 143 | $21,600-$31,300 |
| **4** | 2 Lane Arterial Car v Ped | 1.5 hours | 2,700 | 1.2 mins | 3.5 mins | $8-$12 | 55 | $7,900-$11,500 |

* Including estimated delays to stationary traffic on the motorway upstream of the crash site for 4 hours that are not captured in traffic counts or travel time observations

** expected to be an underestimate as there are likely diversion routes outside of the study area

The large variation in the estimated delay cost due to the four crashes studied, between $7,900-$11,500 and $1.4 to $3.5 million, suggests that a single value of the cost of delays due to crashes would have little meaning.

This small sample study indicates that there can be very large delay costs attributable to crashes, which could make a substantial difference to the economic analysis of some safety and road upgrade projects. This demonstrates the need to consider economic productivity and safety holistically, as network unreliability caused by serious crashes creates significant disruption costs.

The motorway multi-vehicle crash involved serious injury. The NZTA Monetised Benefits and Costs Manual (MBCM) would value the social cost of this crash at $999,600 (May 2025 update factor). The estimated unexpected delay cost of the crash is (at least) $1,420,000, demonstrating that the actual cost to society of this crash might be at least $2.4 million. While this crash may have been especially disruptive, at this level of unexpected delay the benefit: cost ratio of safety improvement schemes could be doubled or tripled.

The analysis of delays due to crashes has shown that there is a very large variability in the delay due to crashes on the road network, which is not determined by the crash severity alone, but heavily influenced by the volume of traffic on the road, the resilience of the surrounding network (the availability of multiple diversion routes), the time of day, and the time taken to clear the crash scene and reopen the road to traffic, if it is closed at all.

A larger research project would enable a clearer and more robust conclusion, which could lead to a significant change in how crash costs are calculated across New Zealand.

## 2. BACKGROUND

The 2024 Government Policy Statement on Transport (GPS)[1] emphasises that the Government's overarching priority is to support economic growth and productivity. A critical element of productivity as it relates to the transport system is the predictability and reliability of journey times.

The ability of freight carriers to keep to delivery schedules, for employees to get to work and to meetings on time, and for tradespeople to keep appointments is critical to a highly productive transport system. When their journeys are disrupted by an unexpected incident, the additional time they need to complete their essential journeys has a disproportionate effect on their ability to do their work.

One of the most disruptive and unpredictable events that can have a major impact on the operation of the road network is a serious crash. This study sought to quantify the network disruption due to serious crashes in Auckland and to attribute a cost to the resulting additional delays to users.

The economic costs of different severities of road crashes are defined within the NZTA Monetised Benefits and Costs Manual (MBCM)[2] and based upon the NZ Transport Agency research report 698[3].

[1] https://www.transport.govt.nz/area-of-interest/strategy-and-direction/government-policy-statement-on-land-transport-2024

[2] https://www.nzta.govt.nz/assets/resources/monetised-benefits-and-costs-manual/Monetised-benefits-and-costs-manual-v2.7.3-volume-1-procedures.pdf

[3] https://www.nzta.govt.nz/assets/resources/research/reports/698/698-monetised-benefits-and-costs-manual-mbcm-parameter-values.pdf

While the cost of crashes includes elements such as loss of life and life quality, loss of output due to temporary incapacitation, medical costs, legal costs, damage to property, and vehicle damage costs[4], it does not currently include any costs arising from the disruption incurred on the road network due to crashes.

Auckland Transport commissioned Flow Transportation Specialists to undertake a small-scale research project to assess the ability to identify the level of network disruption arising from serious crashes, based on observed increases in vehicle travel time on the network following 4 recent serious crashes in the Auckland region, to deliver a better understanding of the range and scale of delays and the subsequent economic cost that can be attributed to the disruption due to serious crashes on the network. We would like to acknowledge the contribution of Ivy Hao, Senior Transport Planner, Auckland Transport, in developing the methodology for this study.

# 3. METHODOLOGY

This assessment has considered the scale of delay experienced on the surrounding road network following crashes using real examples. This initial study has been limited to examining 4 crashes, specifically chosen to reflect different types and severities of crashes, on different road types across different parts of Auckland. The four crashes selected for analysis are summarised in Table 1.

**Table 1: Crashes used in this analysis**

| Crash # | Road Type | Road AADT | Time Period | Severity | Vehicles Involved |
|---|---|---|---|---|---|
| **1** | Motorway | 63,000 | PM pre-peak | Serious | Multiple cars |
| **2** | Divided Arterial | 26,000 | AM post-peak | Serious | 2 cars |
| **3** | 4 Lane Arterial | 23,000 | PM pre-peak | Serious | Car v Motorcycle |
| **4** | 2 Lane Arterial | 18,000 | AM Peak | Fatal | Car v Pedestrian |

We accessed the crash records from the CAS system to help understand each crash and the likely impacts on traffic. The full details of the crashes are not included in this report for privacy reasons.

## 3.1 Traffic Data

We obtained data on the traffic flows and travel times on the day of the crash, and on a typical day (baseline) collected from TomTom GPS units in vehicles. The data included the following:

- Size of TomTom sample per quarter hour
- Estimated traffic flows on links scaled from TomTom and validated with observed volumes from SCATS loops and Telemetry count sites
- Change in journey time compared to baseline

[4] https://www.nzta.govt.nz/planning-and-investment/learning-and-resources/benefits-management-guidance/the-land-transport-benefits-framework/healthy-and-safe-people/changes-in-user-safety/1-1-impact-on-social-cost-of-deaths-and-serious-injuries/

- Total change in vehicle delays compared to baseline.

## 3.2 Data Limitations

- The data provided only provides the difference between travel times along links between the baseline and the crash day, rather than information about the average speed in either situation. This limits the understanding of traffic conditions, eg a 100% increase in travel time could be a decrease in average speed from 40 to 20 km/h, or from 20 to 10 km/h.
- The extent of coverage of the data may not always cover all likely alternative routes and therefore underestimate the network delays.

## 3.3 Analysis

To estimate the extent of network disruption delays that can be directly attributed to a road crash, we studied the supplied traffic flow and travel time change data, while considering three main questions:

1. Is it probable that the crash would have resulted in increased delays on this link, in this direction?
2. Is it probable that the crash would have resulted in increased delays on this link at this time?
3. Is the difference in travel time significant? (i.e. greater than expected in day-to-day variation?). A minimum increase in travel time of 20% was applied.

Only those links which met all three criteria were included in the analysis.

## 3.4 Economic Assessment

The analysis used the composite values of travel time for urban arterials, plus the maximum increments for congestion, from Table 16 of the MBCM, updated to July 2024 values (x1.12). Maximum increment congestion values are considered appropriate as the delays measured directly result from congestion, either on the crash road and approaches or on alternative routes.

To reflect the substantial evidence that time spent in unexpected delays is valued at a much higher rate than normal travel time, this study has applied an "unexpected delay" time multiplier of 3.2, as recommended in NZ Transport Agency Research Report 670[5] . We note this factor has been applied to unexpected delay costs in the economic assessment of recent NZTA projects such as the Northland "Roads of National Significance" and Transport Resilience East Coast (TREC).

RR670 does not establish whether the unexpected delay factor should be applied to both the composite value of travel time and the congestion increment. Our opinion is that in the same way that unexpected travel time is valued at a higher rate than typical travel time, being stuck in unexpected congestion is more frustrating to motorists than being in the normal day-to-day congestion at expected locations on typical journeys.

[5] NZ Transport Agency research report 670 Better measurement of the direct and indirect costs and benefits of resilience July 2020 s 3.4.4.1 Research Report 670 Better measurement of the direct and indirect costs and benefits of resilience

To reflect the uncertainty we have calculated the value of the unexpected delays and congestion with and without the 3.2 factor applied to the congestion increment. The values used are shown in Table 2.

**Table 2: MBCM Values of travel time**

| Time period | Composite value of travel time ($/h/vehicle) | Increment for congestion (CRV) $/h/vehicle) | Unexpected Delay factor (UDF) | Unexpected travel time cost 1 (excluding UDF on CRV) | Unexpected travel time cost 2 (including UDF on CRV) |
|---|---|---|---|---|---|
| **Morning commuter peak** | $37.37 | $27.76 | 3.2 | $147.34 | $208.45 |
| **Daytime Interpeak** | $40.04 | $28.13 | 3.2 | $156.26 | $218.16 |
| **Afternoon commuter peak** | $37.60 | $27.36 | 3.2 | $147.68 | $207.87 |

# 4. DISRUPTION CALCULATIONS

## 4.1 Crash 1 – Motorway Multiple Vehicle Crash

This crash occurred on the motorway network on the North Shore. Three cars were involved, and multiple serious injuries were incurred.

The crash location was remote, with a long distance to the nearest interchange. There are limited alternative routes.

The identified increases in travel time, where the increase can be attributed to the crash, are shown in Table 3.

**Table 3: Crash 1 Additional delays on selected links (vehicle-seconds)**

| Crash 2 | Additional delay compared to baseline (vehicle seconds) | | | | | | |
|---|---|---|---|---|---|---|---|
| **Link** | **14:00** | **15:00** | **16:00** | **17:00** | **18:00** | **19:00** | **20:00** |
| A | 328,307 | 2,319,550 | 1,944,541 | 1,874,200 | 1,591,262 | 227,661 | 0 |
| B | 6,305 | 523,855 | 801,069 | 893,813 | 765,758 | 104,579 | 0 |
| C | 45,941 | 225,439 | 551,924 | 523,159 | 548,,549 | 197693 | 0 |
| D | 144,886 | 653,294 | 1,829,,597 | 1,923,363 | 1,539,481 | 224,385 | 0 |
| E | 18,437 | 286,007 | 521,532 | 757,150 | 216,938 | 3,766 | 0 |
| F | 46,086 | 352,873 | 260,312 | 238,960 | 117,097 | 71,910 | 0 |
| G | 0 | 0 | 0 | 0 | 94,875 | 212,278 | 0 |
| H | 37,065 | 129,236 | 391,662 | 1,432,700 | 169,709 | 415,232 | 0 |
| I | 0 | 0 | 43,598 | 481,535 | 962,668 | 0 | 0 |
| J | 42,198 | 0 | 0 | 0 | 225,836 | 852,824 | 43,313 |
| K | 2,695 | 16,717 | 45,027 | 381,691 | 91,693 | 8,706 | 0 |
| L | 10,3198 | 662,403 | 873,174 | 656,497 | 491,171 | 193,560 | 0 |
| M | 23,244 | 65,612 | 89,175 | 46,084 | 86,661 | 9,906 | 0 |
| N | 2,825 | 50,119 | 182,367 | 309,279 | 230,489 | 0 | 0 |

The sum of the delays in Table 3 is 32.8 million vehicle seconds, or 9,120 hours of vehicle delay.

Using the two daytime interpeak values of unexpected, congested travel time from Table 2 of $156.26 - $218.16 per vehicle hour, the economic value of the delays due to this crash is calculated to be **$1,420,000 - $ 1,990,000.**

We estimate that given the normal flow on the motorway in the crash direction during the closure period is about 3,000 vehicles per hour, and there would also be traffic that normally uses the alternative routes that were subject to delay, the likely number of vehicles affected would be about 20,000. The average delay per vehicle would be about 30 minutes at a cost of about $72-$100.

The maximum delay to an individual motorist is estimated to have been about 3 hours, at a cost of about $450-$650.

**Comments**:

- The location, severity, and time of this crash have all contributed to the very large economic cost of the resulting delay. The crash occurred around 14:00, before the pm peak, but due to the severity of the crash and the remote location, the motorway closure lasted until about 18:00, by which time major widespread congestion had built up on approach roads and diversion routes, which did not clear until about 20:30.
- The observed traffic flows and travel time changes do not capture stationary vehicles. It is very likely that a long queue of stationary vehicles formed on the motorway after the crash and may not have dispersed until the road was reopened some 4 hours later. The crash location was about 5.5 km from the previous interchange. Unless the traffic stuck on the motorway was able to turn around and head back to the previous interchange, there could have been up to 1,800 vehicles stationary on the motorway for up to 4 hours. This would add another 7,200 hours of delay to the figure estimated above, increasing the estimated unexpected delay cost to about $2.5-$3.5 million.
- The analysis does not include any impact on southbound vehicles on the motorway. It is very likely that delays were experienced by southbound drivers due to the "rubbernecking" effect of the crash on the opposing carriageway.

## 4.2 Crash 2 – 6 Lane Arterial Car v Car Crash

This crash occurred at the intersection of a major arterial and a local road at 09:20 on a Thursday. A car turned right out of the minor road and collided with a car in the outside lane. The crash road is very highly trafficked in the morning peak, carrying about 2,300 vph. There are several alternative routes, and we think it is very likely that some diversion routes would have been used for which travel time data was not supplied; therefore, the network disruption is expected to be underestimated. The selected links and times where the increase in travel time can be likely attributed to the crash are shown in Table 4.

**Table 4: Additional delays on selected links (vehicle-seconds)**

| Crash 3 | Additional delay compared to baseline (vehicle seconds) | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Link** | **9:15** | **9:30** | **9:45** | **10:00** | **10:15** | **10:30** | **10:45** | **11:00** | **11:15** | **11:30** | **11:45** |
| A | | 13,905 | 28,272 | 13,911 | 13,986 | 17,428 | 11,905 | 23,642 | 7,504 | 2,572 | |
| B | | 5,040 | 7,625 | 15,351 | 17,672 | 16,640 | 18,144 | 25,740 | 38,571 | 18,760 | 10,353 |
| C | | 2,480 | 4,112 | 3,626 | 2,720 | 5,073 | 4,304 | 5,859 | 7,075 | 8,550 | 6,739 |
| D | 68,200 | 92,444 | 90,228 | 4,665 | 271 | | 110 | 229 | | 262 | |

The sum of the delays in Table 4 is 646,000 seconds, or 179 hours of vehicle delay, noting again we expect this to be an underestimate.

Using the two daytime interpeak values of unexpected, congested travel time from Table 2 of $147.34 - $208.45 per vehicle hour, the economic value of the delays due to this crash is calculated to be **$25,800-$37,400.**

We estimate the likely number of vehicles affected was about 4,500. The average delay per vehicle was then about 2.4 minutes at a cost of about $5.60-$8 per vehicle.

The maximum delay to an individual motorist is estimated to have been about 10 minutes, at a cost of about $24-$35.

**Comments**:

- As for Crash 1, the observed traffic flows and travel time changes do not capture stationary vehicles. The crash road was closed for about 2 hours. In this case, we expect that vehicles were able to be re-routed rather than waiting for the road to reopen, as there is an opportunity to leave the crash road about 150 metres prior to the crash location.

## 4.3 Crash 3 – 4 Lane Arterial Car v Motorcycle Crash

This crash occurred at the intersection of an arterial and a local road, just after 3 pm, on the Auckland Isthmus. A car turned right out of the minor road and collided with a motorcycle. In this location, there are numerous alternative routes available. The selected links and times where the increase in travel time can be likely attributed to the crash are shown in Table 5.

**Table 5: Crash 3 Additional delays on selected links (vehicle-seconds)**

| Crash 3 | Additional delay compared to baseline (vehicle seconds) | | | | | | |
|---|---|---|---|---|---|---|---|
| **Link** | **15:00** | **15:15** | **15:30** | **15:45** | **16:00** | **16:15** | **16:30** |
| A | | 12,390 | 23,936 | 11,682 | | | |
| B | | 5,060 | 3,488 | 8,750 | | | |
| C | 2,484 | 1,026 | | | | | |
| D | 1,704 | 0 | 658 | 504 | | | |
| E | | 12,576 | 41,808 | 36,024 | 41,080 | 85,968 | 35,777 |
| F | | 23,788 | 42,120 | | | | |
| G | | 13,482 | 7,630 | 6,885 | | | |
| H | 25,704 | 4,988 | | | | | |
| I | | | 29,748 | 12,028 | | | |
| J | | 7,810 | 17,088 | | | | |

The sum of the delays in Table 5 is just over 500,000 seconds, or 143.4 hours of vehicle delay.

Using the two daytime interpeak values of unexpected, congested travel time from Table 2 of $156.26 - $218.16 per vehicle hour, the economic value of the delays due to this crash is calculated to be **$21,600**-**$31,300**.

We estimate the likely number of vehicles affected was about 3,700. The average delay per vehicle would be about 2.3 minutes at a cost of about $6-$8.40.

The maximum delay to an individual motorist is estimated to have been about 5.5 minutes, at a cost of about $14-$20.

It is not certain whether the delays observed on Link E after 14:00 can be attributed to the crash, as congestion on other routes had disappeared by 16:00. Excluding the delays on Link E after 16:00 reduces the total delay to 99.5 hours and the total cost to about **$15,500-$21,700**.

**Comment**: The calculated cost of delay due to this crash is modest; we believe the impact was mitigated by the following factors:

- Crashes involving injury to a motorcyclist are likely to be relatively less disruptive than crashes involving injury to a car or van occupant
- The crash location is 4 lanes, and moving the crashed and emergency services vehicles to the left-hand lane would quickly enable one lane to operate. Traffic continued to flow past the crash site.
- There are multiple diversion routes available in the area, and drivers' GPS maps would likely navigate them away from the crash location

## 4.4 Crash 4 2 Lane Arterial Car v Pedestrian Crash

This crash occurred on a minor arterial road on the North Shore in the morning peak. While the road on which the crash occurred is not usually heavily congested, much of the surrounding network is already congested during the morning peak period.

The selected links and times where the increase in travel time can be likely attributed to the crash is shown on Table 6.

**Table 6: Crash 4 Additional delays on selected links (vehicle-seconds)**

| Crash 4 | Additional delay compared to baseline (vehicle seconds) | | | | | | |
|---|---|---|---|---|---|---|---|
| | 8:00 | 8:15 | 8:30 | 8:45 | 9:00 | 9:15 | 9:30 |
| A | 900 | 3,097 | 5,017 | 6,912 | 244 | 2,030 | 1,521 |
| B | | | | 7,605 | | | |
| C | | 28,944 | 24,764 | | | | |
| D | 3,208 | 14,196 | 13,824 | 2,328 | | | |
| E | | | 20,202 | 28,497 | | | |
| F | 408 | 408 | 636 | 345 | | | |
| G | 7,878 | 14,448 | 11,684 | | | | |

The sum of the delays in Table 6 is just under 200,000 seconds, or 55.3 hours of vehicle delay.

Using the two daytime interpeak values of unexpected, congested travel time from Table 2 of $147.34 - $208.45 per vehicle hour, the economic value of the delays due to this crash is calculated to be **$7,900-$11,500.**

We estimate the likely number of vehicles affected was about 2,700. The average delay per vehicle would be about 1.2 minutes, at a cost of about $3.00 - $4.30.

The maximum delay to an individual motorist is estimated to have been about 3.5 minutes, at a cost of about $8-12.

**Comment**: This crash is atypical as it involved very low speed, with no damage to the car involved. Keeping the traffic flowing would have been relatively efficient. This seems to be supported by the low economic impact.

## 5. PEER REVIEW AND RESPONSE

A draft of this technical note was peer reviewed by WSP (memo ref 5-C4726-02 dated 18 July 2015). The peer reviewer's main comments were:

- There are limitations of the scope and methodology could be resolved through additional discussion around the limitations of the data available, and the impacts of the exclusion of the data
- Several potential costs of network disruption such as vehicle operating costs and potentially the "cost" of deferred or cancelled trips have not been included in the analysis. In addition there may be delays on other links not captured by the Mooven data
- The application of the unexpected delay factor to the congestion increment is questionable and there may be other methods to account for unexpected delay costs
- The unexpected delay factor should not be applied if the motorist is likely to have been made aware of the event and the additional travel time / congestion before they decide to make the journey
- Reporting a range of values of delays would be advisable

In response to the peer review, we made the following changes, included in this final technical note:

- Noted that the small scale of this study has limited the scope and driven the methodology.
- Noted that there are several potential costs associated with network disruption due to crashes that are not included in this evaluation, which focusses only on the cost of delays, and consequently the costs reported are likely to underestimate the total cost of disruption.
- Considered the application of the unexpected delay factor. We believe that this is appropriate to address the increased impact of unexpected network delays on road users' lives, the reliability of freight journeys and the productivity disbenefits.
- Considered whether motorists are likely to have any prior warning of delays due to crashes and concluded that in most cases they would have no warning or have little opportunity to delay or cancel their journey or use a different mode of transport.
- Reported the unexpected value of time with and without the unexpected delay factor applied to the congestion increment.
- We emphasise that this is a small pilot study and that many of the peer review comments could be addressed within a larger scale study into this topic.

## 6. CONCLUSIONS

1 The analysis of delays due to crashes has highlighted that there is a very large variability in the delay due to crashes on the road network, which is not determined by the crash severity alone, but heavily influenced by the volume of traffic on the road, the resilience of the surrounding network (the availability of multiple diversion routes), the time of day and the time taken to clear the crash scene and reopen the road to traffic, if it is closed at all.

2 The large variation in the estimated delay cost due to the four crashes studied, between $7,900 and $3.5 million, suggests that a single value of cost of delays due to crashes would have little meaning.

3 This small sample study indicates that there can be very large delay costs attributable to crashes, which could make a substantial difference to the economic analysis of some safety and road upgrade projects. A larger research project would enable a clearer and more robust conclusion, which could lead to a significant change in how crash costs are calculated across New Zealand, with the inclusion of unexpected delay costs.

4 For example, the average network disruption cost of the four crashes studied is at least $400,000. While there is little confidence that this represents the actual average disruption cost of serious crashes in Auckland, due to the small sample size. If the actual average cost of disruption due to serious crashes in Auckland is, for example, $50,000, the annual cost of disruption due to serious crashes in Auckland would be about $27 million[6], or $270 million over 10 years. In addition, minor injury crashes, depending on their location and level of disruption, can lead to as much unexpected network delay as a serious crash. There are more than 2,500 reported minor crashes per year on Auckland's network. If the cost of disruption from each minor injury crash is $10,000, that would add equate to $25 million of network disruption annually and suggests that the cost of network disruption due to all crashes in Auckland over 10 years might be about $500 million.

5 This indicates the value in further research.

Reference: P:\ATST\007 Reporting on Network disruption\4.0 Reporting\T2G250718 Network Disruption due to serious crashes final draft.docx - Phil Harrison

[6] Based on the average number of DSI crashes in Auckland 2019-2023 of 540 per year.