

The transport impacts of the 20 June 2013 storm: The effects of closing the Hutt Valley rail line between Petone and Wellington for multiple days

A joint report by the Ministry of Transport, the NZ Transport Agency, KiwiRail and the
Greater Wellington Regional Council

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Executive summary

Extreme events and disruptions to our every-day lives give us a chance to probe how we react in different circumstances, and consider how we can better react in the case of similar future events.

The storm on the night of Thursday 20 June 2013 severely affected Wellington's transport network, with both immediate and flow-on effects for commuters in the region. Of particular significance was the damage done to the Hutt Valley rail line, and the consequent disruption to passenger rail services for the six days following the storm.

This project surveyed 1,072 Wellington commuters to assess several impacts on Friday 21 June, Monday 24 June and Wednesday 26 June, including:

- the extent to which disruptions to the transport network (in particular the Hutt Valley rail line services) affected the time it took commuters to get to their destination
- how commuters changed their travel behaviour to respond to the network disruptions
- the extent to which communications by transport agencies (including radio, email and text messaging) may have influenced the behaviour of commuters.

Traffic counts provided by the NZ Transport Agency, and public transport patronage data supplied by KiwiRail, were also used to assess the flow-on effects of the storm. The project also undertook an economic evaluation to estimate the economic costs of the storm's impact on the transport network.

The key findings from the survey, traffic counts are as follows:

- The closure of the Hutt Valley rail line put significant pressure on the road network. Delays for commuters were most severe on the Monday following the storm. Traffic on State Highway 2 was severely congested, with morning peak hour conditions lasting two hours longer than usual
 - 80 percent of Wellington commuters from the Hutt Valley and Wairarapa experienced a longer than usual trip
 - 32 percent of them experienced delays of over an hour
- the severity of commuter delays lessened over the week, with the number of commuters from the Hutt Valley and Wairarapa experiencing delays of over an hour halving by Wednesday 26 June
- traffic delays were slightly less severe on Friday 21 June. This may have been due to 27 percent of commuters (surveyed across the region) not travelling to work on the Friday. By Monday 24 June this figure dropped to just 4 percent
- on Monday 24 and Wednesday 26 June, roughly 45 percent of the typical Hutt Valley train commuters opted to drive themselves or be driven to work in a private car, and roughly 45 percent chose the train and bus replacements
- communications by transport agencies were effective, with 75 percent of people surveyed aware of transport delays before they headed to work on Friday, and over half of these people altering their travel plans to respond to conditions.

Research undertaken as part of this project estimated that the economic impacts of transport disruption resulting from the storm was between \$12 million and \$43 million. This included \$5.3 million in cost to local and central government agencies who responded to disruptions and damage on the transport network, \$5.3 million loss in value of travel time and between \$2 million and \$32 million reduction in outputs.

This report will be used to input to contingency planning by the relevant agencies, as well providing information to assist with future physical improvements projects.

1 Introduction

The severe storm of 20-21 June 2013 had both immediate and flow-on effects in disrupting the Wellington transport network. Immediately associated with the storm were ferry cancellations, road closures, airport closures, rail line closures and disruptions to bus services.

Severe erosion of parts of the Hutt rail line between Ngauranga and Petone necessitated closure of the rail line for multiple days with the line reopening on Thursday 27 June.

This report investigates the impact of the closure of part of the Hutt Valley rail line from 21-26 June, and how transport users adjusted their travel patterns and behaviour to cope with it.

It gives an overview of the impact of the storm on this part of the network as detailed by a variety of data sources: State highway traffic counts, rail patronage figures and an online survey of those who commute into Wellington. The survey allows a more detailed investigation of commuter experiences, such as delays experienced, and of how commuters adapted their travel patterns.

The survey allows us to investigate the role of communication in influencing transport choices, by looking at whether people knew about potential transport network disruptions ahead of time, how they found out and if they were able to adapt their transport routine.

The report also examines the estimated economic impact of the disruptions to the transport network. It looks at both direct costs, such as repairs to the rail network, and indirect costs, such as loss of productivity through people being absent from work.

The focus of this report is on the impacts on the Hutt Valley corridor, as it represents a specific break in the transport network and allows for detailed investigation. It is acknowledged that this is just one part of the damage due to the storm and that other areas were also badly affected.

From a practical perspective, the online survey was not limited to those commuting from and through the Hutt Valley corridor and so gathered responses from people across the Wellington region. To make use of all this data, this report also examines region-wide patterns of behaviour during the days following the 20-21 June storm and the experiences of users from different areas are compared and contrasted.

2 Methodology

A variety of sources of information were used to inform our understanding of the transport impacts. Some were established sources, while others were experimental.

2.1 Telemetry traffic count

NZ Transport Agency operates a series of telemetry traffic count sites and vehicle detector loops at traffic signals along State Highway 2, which allow measurement of traffic volumes along the network. This allows us to examine traffic under normal conditions (peak and off-peak) and compare it to that observed when the Wellington-Petone trains were not running. It should be noted the detection methods used work best in uncongested situations, but may not detect all vehicles when travelling at slow speeds or when vehicles are closely bunched. This means that the peak traffic levels at extreme congestion times may be higher than counted.

2.2 KiwiRail patronage figures

KiwiRail routinely monitors rail patronage levels as part of its day-to-day services.

2.3 Online survey of transport impacts on people commuting into Wellington

In order to evaluate the impact of the travel disruption past the patronage and traffic count figures, the Ministry of Transport conducted a survey of people who commute into central Wellington. The Ministry wanted to find out which travel modes they used, what the impact of the storm was, if and how they knew about disruptions to the transport network and if this affected their travel plans.

As a test of online media and internet based surveying techniques, it was decided to use an online based survey tool and to recruit respondents through social media and word of mouth, as well as through more traditional print media. The survey link was posted to various locations and respondents were invited to pass the link on to friends, family and work colleagues. High response numbers were obtained via posting to the Wellington Regional Emergency Management Office's Facebook page and through contacts at the Capital and Coast District Health Board.

The online survey received 1,072 responses from people around the wider Wellington region; 1,056 of these responses were detailed enough to analyse. Care should be taken in interpreting the results in that this is not a representative sample of the population of people in the wider Wellington region, but it does give an indication of the impacts of the storm and how people responded.

For analysis purposes, respondents have been grouped by their area of origin, based on the most convenient rail line to their area:

- the 'Hutt area' (covers Hutt Valley, Stokes Valley, Wainuiomata, Eastbourne and Wairarapa)
- the 'Kapiti area' (covers Tawa (where specified), Porirua, and Kapiti Coast north)
- the 'Other area' (covers the rest of the Wellington region, including Wellington City (excluding where Tawa has been specified)).

Figure 1 shows a map of the Wellington train network.



Figure 1: Geographical map of the Wellington train network.

3 The impact of the storm

During 20-21 June 2013, a severe winter storm affected the Wellington region, along with other parts of New Zealand. In Wellington, strong winds and high waves had a serious impact on infrastructure. At the storm's peak, Wellington Airport recorded sustained wind speeds of 101 km/hr¹, with gusts of 130-140km/hr. The highest gust recorded was 200 km/hr at Mt Kaukau². NIWA recorded wave heights off Baring Head of 15m peak to trough³, the largest seen on record.

Transport impacts over this time period immediately associated with the storm included ferry cancellations, road closures, airport closures, rail line closures and disruptions to bus services⁴.

3.1 Disruptions to rail services Friday 21 June

Focusing on the rail line disruptions, passenger services were severely disrupted on Friday 21 June. Of the rail lines⁵:

- the Johnsonville line was closed, with train services only resuming after 4pm
- the Melling line was closed between Melling and Petone stations. No replacement buses were scheduled

¹ From <http://www.niwa.co.nz/news/storm-and-snow-information-update> accessed 21.8.2013

² From <https://www.facebook.com/MetService?fref=ts&filter=1> 21 June 2013, accessed 21.8.2013

³ From <http://www.niwa.co.nz/news/storm-and-snow-information-update> accessed 21.8.2013

⁴ From <https://www.facebook.com/WREMONz?filter=1> 21 June 2013, accessed 21.8.2013

⁵ From <http://www.stuff.co.nz/dominion-post/news/wellington-weather/8824267/Transport-closures-and-cancellations> accessed 25.9.2013

- the Kapiti line was closed with bus replacement services running. Rail services resumed late evening
- the Hutt line had trains running on a half hour schedule between Upper Hutt and Petone stations. Bus replacement services were run between Petone and Wellington stations
- the Wairarapa train had it's portion of the service between Upper Hutt and Wellington stations replaced by buses.

Damage to the rail tracks included washouts, slips and fallen trees⁶.

3.2 Damage to the Hutt Valley rail line

The damage to the Hutt Valley rail line was the most severe of the damage to the rail network. The storm damaged seven sites along the train line between Kaiwharawhara and Petone. The damage included erosion of the sea wall and destabilisation of the rail tracks and associated overhead poles⁷.⁸ This required round-the-clock repairs, with repair teams alternating 12-hour shifts to get the line back up and running. During the time taken to repair the tracks, trains could not run on that section of the line.

3.3 Disruptions to rail services (Friday 21 to Wednesday 26 June 2013)

While the Johnsonville and Kapiti lines were up and running by the end of Friday 21 June, the Hutt Valley line between Petone and Wellington station was unable to carry passenger services until Thursday 27 June.

Services were adjusted as follows:

- **Upper Hutt Line:** trains ran on a half-hour schedule between Upper Hutt and Petone stations. Bus replacement services ran between Petone Station and Upper Hutt Station as required.
- **Wairarapa Line:** services varied, with a mixture of some cancellations, full and partial bus replacements and some train operation between Upper Hutt and Masterton stations.
- **Melling Line:** passenger rail services did not operate on the Melling Line, however, an hourly bus replacement service ran between Melling Station and Wellington Station.

KiwiRail estimates that between Monday 24 June and Wednesday 26 June they operated approximately 90-100 bus trips between Petone and Wellington each day (including the Wairarapa service replacements between Upper Hutt and Wellington).

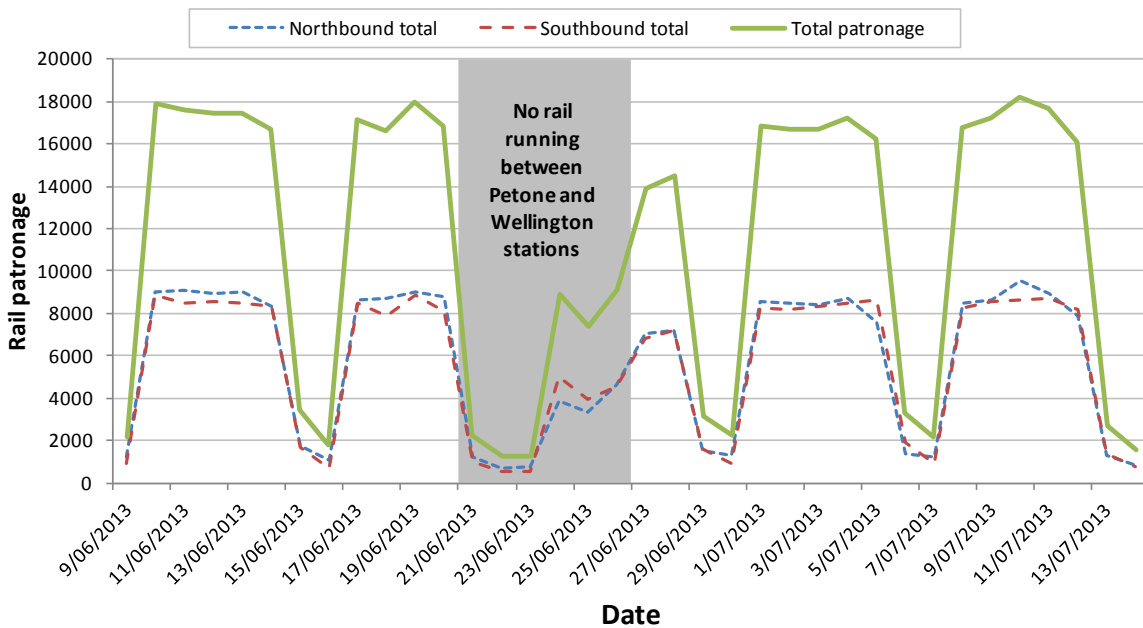
The effects on the Hutt Valley rail network can be seen when the patronage figures are examined. Figure 2 shows the total rail patronage levels along the Hutt Valley line for 9 June to 14 July.

⁶ Ibid

⁷ From <http://www.stuff.co.nz/dominion-post/news/wellington/8851796/Round-the-clock-work-to-put-track-back> accessed 21.8.2013

⁸ From <http://www.stuff.co.nz/dominion-post/news/wellington-weather/8824267/Transport-closures-and-cancellations> accessed 25.9.2013

Hutt Valley rail line patronage: 9 June -14 July 2013



Note: patronage numbers include passengers on trains and bus replacement services

Figure 2: Patronage along the Hutt line for 9 June - 14 July 2013. Grey area indicates when bus replacements ran.

Reductions in total patronage are largest in Friday 21 June, and are roughly half that of usual on Monday 24 June to Wednesday 26 June. Despite full rail services resuming on Thursday 27 June, patronage numbers are still lower than usual for the rest of the week, but return to normal levels the week of Monday 1 July.

4 The role of communications on commuter behaviour

Agencies such as NZ Transport Agency and Greater Wellington Regional Council through Metlink, warned about potential transport disruption due to storm damage on Friday 21 June⁹ and issued warnings about the potential effects of the Hutt Valley rail line closure in the lead up to Monday 24 June e.g. <http://www.nzta.govt.nz/traffic/current-conditions/bulletin/2659/news.html> (see Appendix for 2 other examples of press releases). While such warnings are often released, it is useful to know if people heeded them and what their effect on behaviour was.

4.1 People were well informed

- over three quarters of people knew about potential transport delays on Friday 21 June and Monday 24 June

People were generally well informed of potential delays in the transport system, with 75 percent of people surveyed knowing ahead on Friday 21 June, 78 percent knowing ahead on Monday 24 June and 73 percent knowing ahead on Wednesday 26 June. This had the largest effect on travel on Friday 21 June, with 58 percent of the people who knew ahead changing their travel plans. On the following Monday, 40 percent of people who knew ahead changed their travel plans and by Wednesday 26 June, this had reduced to 35 percent of those who knew ahead changing their travel

⁹ See <http://www.nzta.govt.nz/traffic/current-conditions/bulletin/2656/news.html> accessed 5.9.2013

plans. Changes in travel plan included changing departure times, changing travel mode and not travelling in the first place. The changes in travel behaviour reported are discussed further in section 6.

4.2 How people find out

- The most common way to find out about delays was via radio

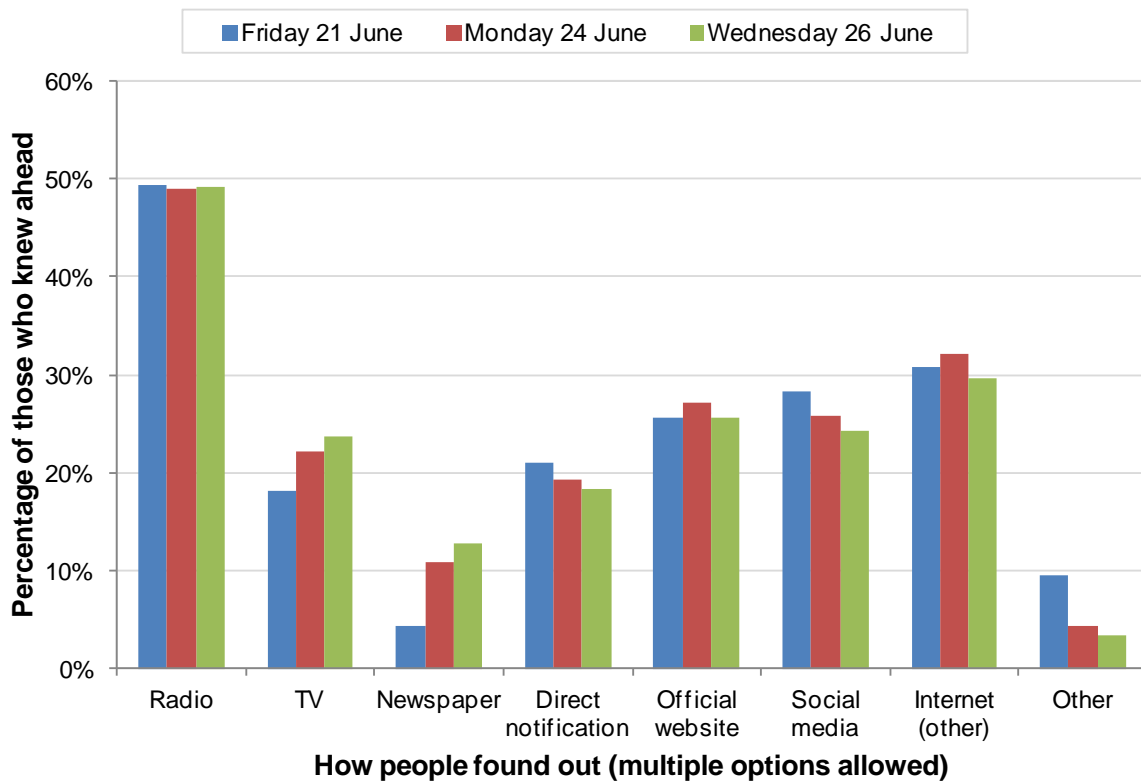


Figure 3: How Wellington commuters found out about delays

People generally found out about delays by multiple methods, with about half of the people surveyed finding out about delays by 2 or more options. The most commonly cited means of finding out about transport delays was via the radio. Other popular means were via official websites eg NZ Transport Agency, Metlink, Tranz Metro, social media such as Facebook or Twitter, or other internet sites ie news sites. Direct notification (eg text alerts, email, twitter message from Tranz Metro, Metlink or NZ Transport Agency) was less common overall, but was particularly popular with those who mainly travelled by train. About half of those who regularly travelled by train and heard about the delays early on Friday found out by direct notification.

5 Effects on Wellington commuters

The expected disruptions to the transport network from the rail line closure resulted in the predicted heavy congestion on Monday 24 June and during the subsequent week. The effects were observed in the traffic counts on the State highway network and in reports from these surveyed of how long their commute took compared to usual.

5.1 Congestion on State Highway 2

State Highway 2, between Petone and Wellington experienced severe congestion and travel time delays in the days following the storm and the closure of the rail line between Wellington and Petone.

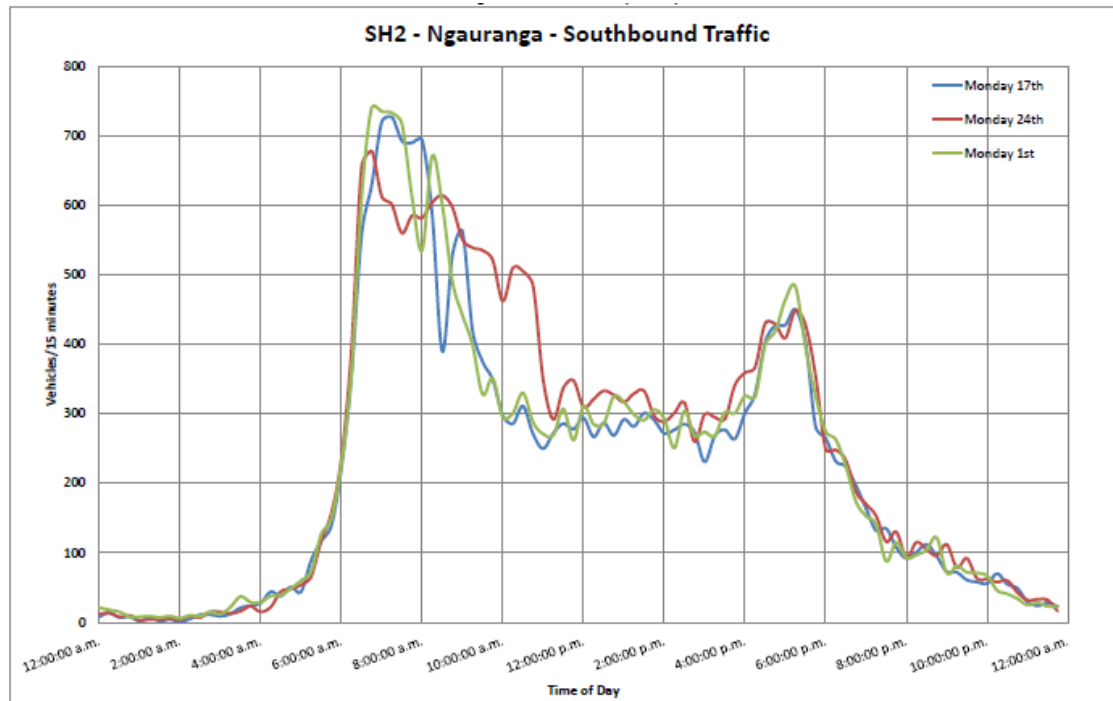


Figure 4: SH2 Ngauranga southbound traffic rates¹⁰

Figure 4 shows the prolonged period of congestion experienced on Monday 24 June when the Hutt Valley rail line was not operational, through the extended period of the morning peak. The graph compares three different southbound traffic counts recorded by the NZ Transport Agency at Ngauranga Gorge on State Highway 2. This includes two counts in normal conditions, where all rail lines were operational (Monday 17 June prior to the storm, and Monday 1 July following repairs to the rail line), and one count on Monday 24 June when the Wellington to Petone rail line was not operational.

The graph shows that on Monday 24 June, when the rail line was closed, peak traffic conditions (more than 500 vehicles per 15 minutes) lasted two hours longer than during normal circumstances (Monday 17 June and 1 July).

It should be noted that the traffic count technology, used by the NZ Transport Agency to compile this data, works best in uncongested situations. As such, it may not detect all vehicles when traffic is moving at slow speeds or when vehicles are closely bunched. This means that the peak traffic levels at extremely congested times on Monday 24 June were probably higher than shown in Figure 4.

¹⁰ From NZTA Wellington Storm – Travel impact report 24 June 2013

Anecdotally, NZ Transport Agency staff travelling in from the Hutt, observed that a cause of a major delay in the journey along State Highway 2 along the harbour was drivers looking at the working crew attempting to fix the railway.

5.2 Congestion and travel time delays during weekdays without train services

Looking at the storm transport disruption in more detail, the congestion and delays can be examined on a day by day basis.

Friday 21 June

Congestion on the road network was not observed and any delays experienced were a direct result of storm damage.

- overall, 54 percent of people who travelled to work took longer than usual to come in
- 76 percent of people from the Hutt who travelled to work took longer than usual to get in; 26 percent took more than an hour longer than usual
- the Kapiti area was also affected, with 58 percent of those travelling to work taking longer than usual, but delays were less extreme; 11 percent took more than an hour longer than usual.

Saturday 22 June and Sunday 23 June

Wellington commuters were not surveyed for travel on Saturday 22 June and Sunday 23 June.

Monday 24 June

Gridlock conditions were observed¹¹ over the wider Wellington area (State Highway 1 and 2) during the morning rush hour, and the larger than usual volume of traffic took longer to clear through the system. Heavy congestion was reported between Melling and Wellington¹². Traffic southbound on State Highway 2 was reported as only returning to normal flow patterns around 10:45am on Monday 24 June¹³.

- for 80 percent of surveyed commuters into Wellington from the Hutt Valley and Wairarapa, their trip to work took longer than usual
 - for 32 percent of surveyed commuters travelling into Wellington from the Hutt Valley and Wairarapa, it took an hour longer than usual to get in
 - in contrast, 85 percent of surveyed commuters from the Kapiti area experienced no delays or took less than half an hour longer than usual to come in.

¹¹ From <http://www.stuff.co.nz/dominion-post/news/hutt-valley/8833240/Hutt-traffic-grinds-to-a-standstill> accessed 21.8.2013

¹² Ibid

¹³ Ibid.

Tuesday 25 June

- Wellington commuters were not surveyed for their travel to work on Tuesday 25 June, but travel time delays of up to an hour were reported in the media¹⁴.
- Heavy congestion was reported, however, traffic was slowed down, rather than stationary¹⁵.
- Traffic queues were cleared by 10am, compared with 10:45am the previous day.

Wednesday 26 June

- Traffic levels were still greater than usual, with delays observed, but traffic queues cleared faster than the previous days. For example, NZ Transport Agency reported traffic blocked up “from Aotea Quay to the intersection of State Highway 2 and the Haywards Hill, as well as up the Ngauranga Gorge towards Johnsonville” at 8:30am, but that traffic was flowing smoothly by 9am.
- 76 percent of commuters surveyed coming into work from the Hutt Valley and Wairarapa took longer than usual.
 - For 15 percent of surveyed commuters coming to work from the Hutt Valley and Wairarapa, it took an hour longer than usual to come in.
 - In contrast, 31 percent of surveyed commuters from the Kapiti area took longer than usual to come in.

Examples of people’s experiences of delays reported in the media can be found at

<http://www.stuff.co.nz/dominion-post/news/hutt-valley/8833240/Hutt-traffic-grinds-to-a-standstill> (accessed 21.8.2013), and <http://www.stuff.co.nz/dominion-post/news/8835959/Commuter-chaos-plagues-capital> (accessed 21.8.2013).

6 Behaviour change during network disruptions

As well as looking at the effects on commuters – delays and congestion experienced – we can examine how they adjusted their behaviour in reaction to the network disruptions. We can look at whether they could get in to work and, if not, if they could work from home. We can also look at how people travelled to work – if they used their usual mode of travel and, if their usual mode of transport was not available, what alternate arrangements they were able to make. We can also see if people were able to vary their departure time and if that had any effect on their travel experiences.

6.1 Staying home

On Friday 21 June, people were advised to take care on the roads and “*if at all possible, people should think about delaying trips or even staying home*” (via <https://www.facebook.com/WREMONz?filter=1>, Wellington Mayor Wade Brown’s comments).

¹⁴ Ibid

¹⁵ From <http://www.stuff.co.nz/dominion-post/news/8835959/Commuter-chaos-plagues-capital> accessed 21.8.2013

Of the people surveyed, 947 people would normally have worked on this day and of these, 257 people (27 percent) didn't travel to work. Those from the Hutt area (38 percent) and Kapiti area (36 percent) were more likely than those from other areas (18 percent) not to make it to work.

Of those who stayed home, some were able to work from home. Overall, 116 people were able to work from home (59 from the Hutt area, 19 from the Kapiti area and 38 from other areas). However, as an indicator of work flexibility, this is limited as some may not have the types of jobs that could be done from home and, due to the widespread power outages, many may not have been able to work at home regardless.

By the following Monday, most people were able to travel to work if they usually intended to. Only 4 percent of those people surveyed could not make it to work. By Wednesday, this had dropped to 2 percent.

6.2 Mode of travel – did people change how they travelled?

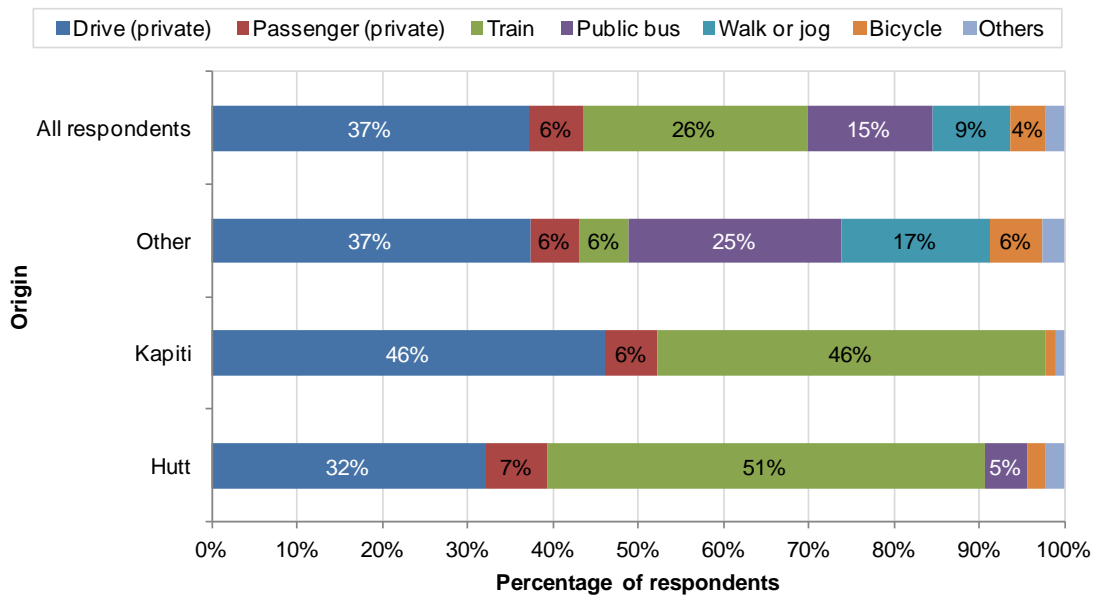
A major component of people's travel behaviour is the mode by which they choose to travel. In order to see how people's behaviour changed, we asked what people's main mode of transport to work was on a typical day. Like the New Zealand Census question on the subject, where multiple travel modes were used (for example, driving to the train station, catching a train, and then walking from the station to work) we asked people to choose the main one based on the greatest distance travelled. We then asked if those who travelled to work on Monday 24 June and Wednesday 26 June what their main travel mode was on these days.

Figure 5 shows how the people surveyed travel to work on a typical day and on Monday 24 June. Overall, on a typical day, more than two in five people surveyed drive or are a passenger in a private vehicle when going to work (43 percent). However, this proportion drops in the Hutt area with over half the people surveyed usually taking the train (51 percent).

In comparison, on Monday 24 June, overall a lower proportion of people took the train (16 percent of all respondents), and a greater proportion of people drove or were a passenger in a private vehicle (55 percent of all respondents). The greatest shift was in those from the Hutt area with less than a quarter of those people surveyed taking the train and replacement bus service (22 percent).

The mode choice changes can be examined in more detail by looking at people's mode choices on a day-by-day basis.

On a typical day: main mode of transport to work (by distance)



Monday 24 June: Main mode of transport to work (by distance)

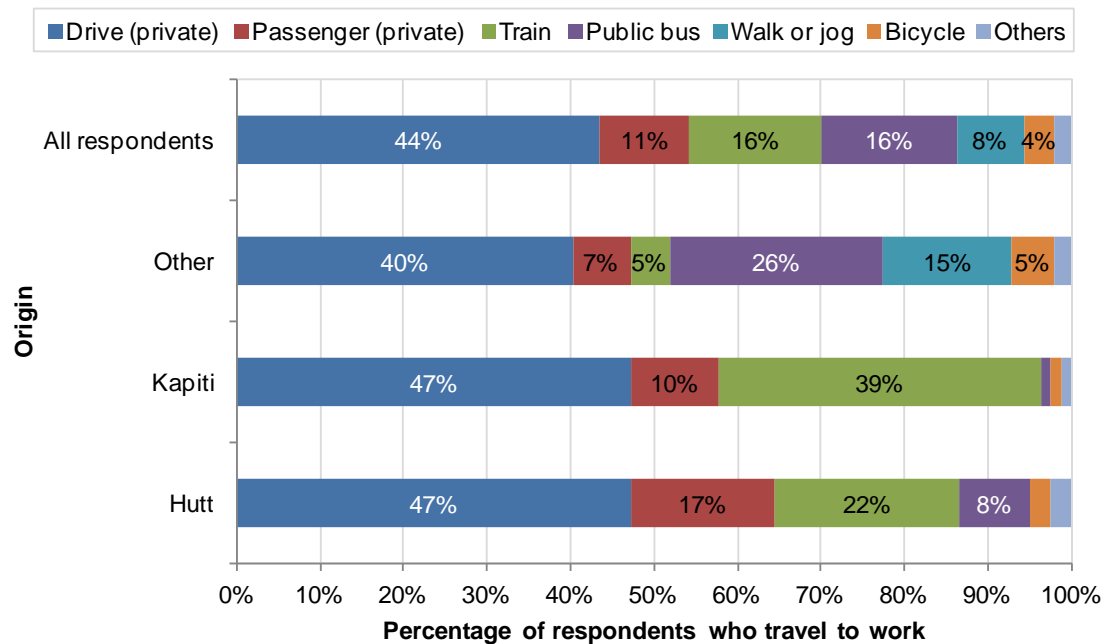


Figure 5: Main mode of transport to work (by distance) – typical day and Monday 24 June

Friday 21 June

As far fewer of the people surveyed travelled in on Friday 21 June, sample sizes are too small to examine changes in mode choice by area. However, the overall mode changes can be examined.

- Over a quarter of those surveyed going to work did not use their typical mode of transport (29 percent).

- Those most likely to change their travel mode were those who typically travelled by train (73 percent of those who changed modes).
- Of the 119 people surveyed who usually take the train and travelled on Friday, 27 percent took the provided replacement bus services.
- Of those who didn't take the replacement bus, nearly half (48 percent) of those who travelled drove a private vehicle and another third (36 percent) were passengers in a private vehicle.
- Over three quarters of those who usually bicycle, motorcycle or take the harbour ferry found other means of transport.
- More than 60 percent of people who said they typically walk or jog to work in the Wellington region still did so, despite the continued wet and wild weather conditions.

Monday 24 June

By Monday 24 June, the repairs to other parts of the rail network meant that the rail disruptions were constrained to the Hutt Valley rail line and the associated Wairarapa and Melling rail lines. This had an effect on who needed to change their travel mode with only 19 percent of all respondents travelling on Monday using a different mode of travel.

- Those from the Hutt area were still most likely to change their travel mode, with 32 percent of them changing, compared with 13 percent for the Kapiti and other areas.
- Those who usually took the train were most likely to find alternate means of transport. Of the 143 people who would normally take the train from the Hutt and Wairarapa, 44 percent still caught the replacement services available, but of those who didn't catch the bus replacement services, nearly half (49 percent) drove a private vehicle and an additional third (34 percent) were passengers in private vehicles. 14 people took other modes of transport including scheduled bus services.

Wednesday 26 June

By Wednesday 26 June, travel patterns were similar to Monday, with 16 percent of the people who travelled to work not using their usual travel mode.

- The majority of those who had changed from their usual transport mode still from the Hutt area. However, nearly 70 percent of those from the Hutt area had resumed their usual travel mode.
 - Of those who typically take the Hutt train and worked on Wednesday (139 people), like Monday, nearly half (46 percent) were catching the replacement services. Of the remaining Hutt typically-train commuters, over half drove a private vehicle (53 percent) and 28 percent were passengers in a private vehicle. Fourteen people took other modes of transport including scheduled bus services.

6.3 Adjusting leaving times

Another means of changing travel behaviour in reaction to an adverse event, is to change the time of travel. People may leave for work earlier in the day to avoid predicted delays due to heavy traffic, or to allow for longer travel times in order to arrive at work on time. If people have the work flexibility

available, they may also try to travel to work later in the day to avoid congestion or give network repairs time to occur.

Friday 21 June

On Friday 21 June, those who travelled to work travelled at a range of times. Of those who travelled from the Hutt area (178 people), over half (51 percent) left for work earlier than usual, 31 percent departed at their usual time and 19 percent departed later than usual.

Monday 24 June

By Monday 24 June, of those who travelled to work from the Hutt area (285 people), a similar proportion to Friday departed at their usual time (32 percent). More people departed for work earlier than usual (61 percent) and less of them later than usual (8 percent).

Changing the time they left for work had little effect in avoiding delays for those from the Hutt area – whether they left for work early, at their usual time or later, over half of those surveyed experienced delays of half an hour or more.

Wednesday 26 June

On Wednesday 26 June, people continued to leave for work earlier than usual. Of those who travelled from the Hutt area (267 people), over half (57 percent) left for work earlier than usual, 34 percent departed at their usual time and 9 percent departed later than usual.

Changing the time they left for work still had little effect in avoiding delays. Of the 57 percent of the Hutt area commuters who left for work earlier than usual, 62 percent of them experienced delays of half an hour or more.

6.4 Long-term changes not observed

It is useful to know if the experiences of people during the rail outage led them to change their travel patterns long term, as opposed to just during the duration of the outage.

The survey asked if, during the week people were completing this survey (about a month after the storm), they travelled at the same time of day and used the same means of transport as they did before the storm? 11 percent reported travelling at a different time or by a different mode to before the storm, so little change was observed. Care should be taken in interpreting this, however, as part-way through the surveying period, a magnitude 6.5 earthquake struck near Seddon on Sunday 21 July, affecting the Wellington region. On the following Monday (22 July) people were discouraged from coming into the Wellington Central Business District to allow safety assessments¹⁶. While the question was changed to ask people to exclude interruptions due to the quake, there may have been some effect.

From Figure 2, rail patronage figures returned to previous levels in the subsequent weeks.

¹⁶ From <http://www.stuff.co.nz/national/8946666/Wellington-streets-deserted-after-quake> accessed 29.8.2013

7 Economic impacts of the storm

As transport plays a key role in enabling economic growth and productivity, the transport disruptions resulting from the Wellington Storm had direct and other flow-on impacts on the economy. There are several aspects from which the economic impacts of natural disasters such as storms could be assessed. Considering the scale of the event, the effects of transport disruption resulting from the Wellington Storm were estimated using two approaches:

Welfare approach:

- Additional communication costs (for notifying travellers about delays and other transport service arrangements)
- Costs of provision of bus services to replace rail services due to damages to rail infrastructure
- Costs of remediation and restoration to transport infrastructure
- Output loss due to reduced work hours
- Cost of increased travel time

Gross output approach:

- Economic impacts of transport disruption on regional output (in terms of direct, indirect and induced effects)

The first group of components relate to the costs associated with transport disruptions from a welfare perspective, akin to the conventional transport cost-benefit analysis approach. The second approach refers to the economic impacts of transport disruptions on Wellington's regional output based on input-output analysis. Table 1 summarises the mid-range estimates. A more detailed report is available in the Appendix, however, a brief summary is provided here.

Table 1: Economic impacts of transport disruption resulting from the Wellington Storm – mid-range estimates

Economic impact component	Welfare approach	Gross output approach with welfare impacts added
	\$ million	\$ million
Additional communications cost	\$0.041	\$0.041
Costs of provision of bus replacement services	\$0.200	\$0.200
Cost of remediation and restoration to transport infrastructure	\$5.080	\$5.080
Output loss	\$3.352	n/a
Gross output impacts	n/a	\$21.530
Value of increase travel time	\$5.321	\$5.321
Total – mid-range estimate	\$13.994	\$32.171

Note: Figures may not sum to totals due to rounding.

According to the welfare approach, the total economic cost of transport disruptions resulting from the Wellington Storm was estimated at between \$12.3 million and \$15.7 million, with a mid-range estimate of \$14.0 million.

Using the gross output approach supplemented with appropriate welfare cost estimates, the total economic cost was estimated at between \$21.4 million and \$42.9 million, with a mid-range estimate of \$32.2 million.

Thus, the overall economic impact of transport disruption resulting from the Wellington Storm was estimated at between \$12.3 million (low-end estimate of the welfare approach) and \$42.9 million (high-end estimate of the gross output approach). Although there are considerable uncertainties around these estimates, results show that the overall impact is relatively small comparing to the size of the Wellington economy of around \$27 billion Gross Domestic Product per annum. This result indicates Wellington's transport network is highly resilient in responding to small scale natural disasters such as the Wellington Storm.

8 Additional observations and conclusions

8.1 Additional observations

In addition to the effects of commuters and changes in travel behaviour discussed earlier, there are a few other points to be made.

- The withdrawal of rail services led to a marked increase in use and therefore pressure on the road network. However, after a couple of days people were able to adjust what they were doing, resulting in less extreme congestion. However, the large impact of needing to reroute the people who normally travel by train demonstrates how much pressure the rail network takes off the road network.
- People were able to adapt their travel plans somewhat (by changing travel mode or changing travel time, or working from home) based on prior information. However there were limitations. Some surveyed individuals made comments that they did not have the option not to work, or to work from home.
- Recommendations to avoid delays by either leaving for work earlier or later benefitted the system in that it redistributed the congestion over a wider period of time and hence reduced the overall problem, but did not necessarily benefit the individuals involved. That is those who left for work earlier or later than usual did not experience shorter delays than those who left for work at the usual time. This may mean that individuals are less likely to heed recommendations in future as it didn't benefit them personally.
- For those who normally take the train but didn't, the main alternate travel mode of choice was to drive a private vehicle. Being a passenger was far less common. Car pooling was occasionally mentioned in the available free text field, but did not appear to have been used much. However its take-up was far more predominant following the complete rail line closures in association with the 19 August 2013 Lake Grassmere earthquake¹⁷. Anecdotally there was mention of people who would normally have taken the train, driving in and stopping at their usual station to offer lifts in the week of 24 June.
- Those travelling in private vehicles from the Hutt Valley and Wairarapa who were surveyed were less likely overall to experience delays coming in on Monday 24 June (29 percent experienced no delays) and Wednesday 26 June (27 percent experienced no delays). However a large proportion were still caught up in the traffic delays, with 22 percent taking more than an hour longer than usual to get to work on Monday, reducing to 14 percent taking more than an hour longer than usual to get to work on Wednesday.

¹⁷ From <http://www.stuff.co.nz/national/9052488/Commuters-rally-to-help-the-stranded> accessed 8.9.2013

8.2 Recommendations

- Maintaining and improving lines of communication between public transport operators and passengers during events like this is essential. Given the circumstances, train users were generally understanding of the situation and appreciative of the efforts made to supply replacement services (within the constraints of buses available) and repair the damage to the line¹⁸. But it helped when they knew what was going on.
- While texting and new social media were a common means of staying informed, the informing power of standard media such as radio should not be neglected.
- Car pooling was not mentioned much by those surveyed as a travel mode option, but offers a useful means of reducing congestion by increasing car occupancy, both in the case of emergencies involving rail closures or delays, and for day-to-day commuting.
- Encouraging conversations about the use of carpooling for such events, and raising awareness of letscarpool.govt.nz, may assist to relieve pressure on the roading network in future events.

¹⁸ From <http://www.stuff.co.nz/dominion-post/news/8835959/Commuter-chaos-plagues-capital> accessed 21.8.2013 and feedback from the survey

Appendix A

Economic impacts of transport disruptions resulting from the June 2013 Wellington Storm

November 2013

Executive summary

This report provides a summary of the estimated economic impacts of transport disruptions resulting from the storm occurred in Wellington in June 2013. The analysis adopted two approaches – the welfare approach and the gross output approach.

According to the welfare approach, the total economic cost of transport disruptions resulting from the Wellington Storm was estimated at between \$12.3 million and \$15.7 million, with a mid-range estimate of \$14.0 million.

Using the gross output approach supplemented with appropriate welfare cost estimates, the total economic cost was estimated at between \$21.4 million and \$42.9 million, with a mid-range estimate of \$32.2 million.

Thus, the overall economic impact of transport disruption resulting from the Wellington Storm was estimated at between \$12.3 million (low-end estimate of the welfare approach) and \$42.9 million (high-end estimate of the gross output approach). Although there are considerable uncertainties around these estimates, results show that the overall impact is relatively small comparing to the size of the Wellington economy of around \$27 billion Gross Domestic Product per annum. This result indicates Wellington's transport network is highly resilient in responding to small scale natural disasters such as the Wellington Storm.

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A1. Overview

Due to its geographic locations, New Zealand is subject to southerly storms during the winter months. However, the winter storm that hit New Zealand during 20-21 June 2013 was considered as one of the strongest in more than 50 years. The storm affected the Wellington region, along with other parts of New Zealand. For brevity, we refer this event as the Wellington Storm throughout this document.

The damages of the Wellington Storm started on the night of 20 June 2013 when heavy rain and strong winds damaged the Wellington rail traffic signals. All Wellington regional train services¹⁹ came to a complete halt from around 8 pm that evening with no bus replacement available due to bad weather conditions. In the following 24 hours, severe weather continued which caused damages to the seawalls and other infrastructure in exposed locations. Some roads were blocked by fallen trees and other debris turning the transport network into chaos. Rail transport services were also seriously affected due to slips and tree fallings onto the tracks. There was also erosion of the sea wall and destabilisation of the rail tracks and associated overhead poles on the Hutt Valley rail line.

As transport plays a key role in enabling economic growth and productivity, these transport disruptions had direct and other flow-on impacts on the economy. There are several aspects from which the economic impacts of natural disasters such as storms could be assessed. Considering the scale of the event, the effects of transport disruption resulting from the Wellington Storm were estimated using two approaches:

Welfare approach:

- Additional communication costs (for notifying travellers about delays and other transport service arrangements)
- Costs of provision of bus services to replace rail services due to damages to rail infrastructure
- Costs of remediation and restoration to transport infrastructure
- Output loss due to reduced work hours
- Cost of increased travel time

Gross output approach:

- Economic impacts of transport disruption on regional output (in terms of direct, indirect and induced effects)

The first group of components relate to the costs associated with transport disruptions from a welfare perspective, akin to the conventional transport cost-benefit analysis approach. The second approach refers to the economic impacts of transport disruptions on regional output based on input-output analysis. These are discussed in detail in the following sections.

The majority of the transport services resumed operations by Monday the 24th of June 2013. However, the Hutt Valley rail line only resumed services on 27 June 2013. Therefore, the following analysis focused on the period from Friday 21st of June 2013 to Wednesday 26th of June 2013. This analysis only looked at the economic impacts due to transport disruptions. It did not estimate all the economic costs to home owners (eg damages to houses) and economic impacts to all businesses (eg damages to crops) resulting from the storm itself.

¹⁹ This included the Johnsonville, Kapiti, Hutt Valley, Melling and Wairarapa lines.

A2. Additional communication costs

At the times of natural disasters, communications play a crucial role in minimising the potential harms caused by the events and in managing the process during the recovery phase of the events. In general, the better informed the citizens are, the better prepared they can be to get through the events.

As discussed in the main report, transport users were relatively well-informed about potential transport delays²⁰. Many transport users were able to utilise such information to make appropriate transport plans to minimise the impacts on them. One key communication channel was direct notification such as text alerts, which have been used by Tranz Metro for many years to notify rail users any disruptions or delays. During the period from 20th to 26th of June 2013²¹, KiwiRail issued multiple text alerts a day to keep users updated about availability of rail services, frequency and delays. KiwiRail estimated that the additional costs of communications took place during the storm period amount to around \$41,000.

There were also costs associated with extra communications support provided by the New Zealand Police, the New Zealand Transport Agency and the Greater Wellington Regional Council (GWRC) to minimise the disruptions to transport users. These have been excluded from the analysis because they are relatively minor in nature and their omissions should not materially affect the final estimate.

A3. Cost of provision of alternative transport arrangement

To help ease the increased road travel demand pressure resulting from rail service disruptions, the Greater Wellington Regional Council (GWRC) and KiwiRail offered limited bus services to replace the normal train services. GWRC estimated that this arrangement incurred an additional cost of around \$200,000.

A4. Costs of remediation and restoration to transport infrastructure

The total cost of remediation and restoration to transport infrastructure is estimated at \$5.08 million (see Table A1). This covers clean up costs and costs of repairs and other remedial work incurred to WCC, GWRC and KiwiRail.

²⁰ Survey of travel behaviour during the storm period carried out by the Ministry of Transport indicated that around three-quarters of travellers knew about possible travel delays prior to their travel.

²¹ All rail services were restored in the morning of 27th June 2013.

Table A1: Costs of remediation and restoration to transport infrastructure

Description	Cost incurred to	Estimated costs (\$ million)
Repair the roads and seawalls around the harbour and South Coast	WCC	\$2.50
Repair to seawalls and other remedial works to restore the rail lines	GWRC (62.5%) and KiwiRail Group (37.5%)	\$1.08
Other clean up costs (including clearing of fallen trees) (note)	WCC	\$1.50
Total		\$5.08

Note: Due to a lack of information, it has been assumed that 100% of the clean up costs are transport related (eg cleaning up roads and footpaths). Data sources: GWRC, WCC and KiwiRail.

A5. Output loss due to reduced work hours

As discussed in the main report, many rail services (in particular the Hutt Valley line) were either cancelled or operated at reduced frequency from 21st to 26th of June 2013. This disruption increased the number of cars travelled on the road and resulted in severe delays and road congestion. The cancellation of rail services and the additional congestion delays increased commuting time and thereby reduced total work hours, which in turn led to a reduction in the level of output produced. This output loss can be estimated using equation 5.1 below.

$$\left[\begin{array}{c} \text{Estimated} \\ \text{output} \\ \text{loss due} \\ \text{to reduced} \\ \text{work hours} \end{array} \right] = \left[\begin{array}{c} \text{Average} \\ \text{hourly} \\ \text{earnings} \\ \text{per person} \end{array} \right] * \left[\begin{array}{c} \text{Estimated} \\ \text{reduction in} \\ \text{total number of} \\ \text{work hours} \end{array} \right] * \left[\begin{array}{c} \text{Temporary} \\ \text{output lost} \\ \text{adjustment} \end{array} \right] \quad (5.1)$$

The three key components required for this assessment are:

- Average hourly earnings per person
- Estimated reduction in total number of hours worked
- Temporary output lost adjustment

These are discussed in the sections below.

A5.1 Average hourly earnings per person

The value of output loss can be proxied by the average earnings received by Wellington employees. According to Statistics New Zealand, average weekly earnings per person²² for Wellington Regional Council area was \$1,088 for the June quarter in 2013. This means the average earnings per hour per person was \$27.20 (based on 40 hours per week). Using a marginal income tax rate of 23%, average hourly earning per person is \$20.94 per hour, exclusive of income tax.

²² Source: Statistics New Zealand.

A5.2 Estimated reduction in total number of work hours

Reduction in total number of work hours can be calculated by multiplying the number of commuters affected by the difference between the estimated number of hours worked during a typical working and that during a storm affected day, as illustrated in equation 5.2.

$$\left[\begin{array}{c} \text{Estimated} \\ \text{reduction} \\ \text{in total} \\ \text{number of} \\ \text{work hours} \end{array} \right] = \left[\begin{array}{c} \text{Estimated} \\ \text{number of} \\ \text{commuters} \\ \text{(by car or PT)} \\ \text{on a typical} \\ \text{working day} \end{array} \right] * \left[\left(\begin{array}{c} \text{Average} \\ \text{number of} \\ \text{work hours} \\ \text{per person} \\ \text{per typical} \\ \text{working day} \end{array} \right) - \left(\begin{array}{c} \text{Average} \\ \text{number of} \\ \text{work hours} \\ \text{per person} \\ \text{per storm} \\ \text{affected day} \end{array} \right) \right] \quad (5.2)$$

The total number of employment²³ in the Greater Wellington region is 264,600 in 2013. For employees who walk or cycle to work (eg those work in local areas), it has been assumed that their total work hours have not affected by transport disruptions²⁴. Therefore, equation 5.2 only applies to car and public transport (PT) users as they would be affected by transport disruptions. Based on GWRC's transport modelling results, it has been estimated that there are around 93,890 commuters travelling either by car (including both drivers and passengers) or by public transport each day²⁵.

Survey data indicated that around 27.1% of the respondents did not go to work as intended due to transport disruptions on Friday (21 June 2013). This share fell to 3.6% and 2.3% for the following Monday (24 June 2013) and Wednesday (26 June 2013) respectively. However, over half of those who did not go to work managed to work from home (12.2% on Friday, 1.6% on Monday and 1.7% on Wednesday). Therefore, some 14.89%, 1.95% and 0.54% did not work as intended during Friday, Monday and Wednesday respectively.

Average number of work hours per person per typical working day was assumed to be 8 hours. This is similar to the average number of hours worked by respondents who did not experience any time lost resulting from the storm during the three surveyed days, estimated at 7.95 hours.

Survey results indicated that for those who did work (either at home or at work), the estimated number of hours worked per day reduced to 6.9 hours, 7.6 hours and 7.74 hours for the affected Friday, Monday and Wednesday respectively. When comparing to the average number of hours worked during a typical working day of 8 hours, the level of reduction is relatively small (between 0.26 hours and 1.1 hours). This is because travellers were well-informed about the traffic conditions during that period and many were able to alter their travel plans to minimise the impacts on them.

Table A2 shows the estimated total number of work hours lost was the highest for Friday (21 June 2013), estimated at 199,756 hours. This fell to 51,656 the following Monday and to 28,597 the following Wednesday. The storm survey did not cover Tuesday the 26th of June 2013. Therefore, the number of work hours lost during that day was derived by interpolation²⁶.

²³ Source: Statistics New Zealand

²⁴ Survey indicated by 60% of those who would normally travel to work on foot or by bicycle did not change their travel mode during the storm affected days. The remaining 40% changed their travel plans due to bad weather conditions.

²⁵ GWRC's transport model has 2011 as the base. The estimated number of commuters in 2013 has been adjusted by the reduction in the level of employment (of 2.1%).

²⁶ This is obtained by taking the average of the estimates for Monday and Wednesday.

Table A2: Estimated total number of work hours lost

Storm affected days	Percentage of people who did not work as intended	Average number of hours worked per person (either at home or at work)	Total number of hours lost for those who did not work as intended	Number of hours lost for those who did work (either at home or at work)	Estimated total number of work hours lost
	A	B	C = 93,890 * A * 8 hours	D = 93,890 * (1-A) * (8 hours – B)	E = C + D
Friday (21 June 2013)	14.89%	6.90	111,834	87,921	199,756
Monday (24 June 2013)	1.95%	7.60	14,667	36,989	51,656
Tuesday (25 th June 2013)		Interpolated			40,126
Wednesday (26 June 2013)	0.54%	7.74	4,038	24,559	28,597

Note: Figures may not sum to totals due to rounding.

A5.3 Temporary output loss adjustment

Some of the potential output losses due to reduced work hours would be temporary in nature. This is because employees could catch up with their work by working more productively or working longer hours in subsequent periods. Further, some output losses could be in the form of a transfer between different parts of the region. For example, a sandwich maker might have experienced a reduction in the demand for sandwiches in Wellington Central Business District (CBD) during the storm affected days due to a reduced number of people working in the CBD. Some of this effect, however, could be offset by an increase in the demand for sandwiches in the local areas.

Therefore, an adjustment is needed to account for such effects. Based on an objective judgement on the likelihood for each industry to experience permanent loss and the shares of the Wellington GDP by industry, it has been estimated that between 25% and 75% (mid-range 50%) of the potential output losses could be temporary only (see Table A3).

Table A3: Deriving the adjustment factor for temporary output loss

Industry group	Scenarios		
	Low	Mid-range	High
Agriculture		Y	Y
Forestry, fishing, mining, electricity, gas, water and waste services		Y	Y
Manufacturing	Y	Y	Y
Construction	Y	Y	Y
Wholesale trade		Y	Y
Retail trade		Y	Y
Accommodation and food services	Y	Y	Y
Transport, postal, and warehousing	Y	Y	Y
Financial and insurance services			Y
Rental, hiring, and real estate services	Y	Y	Y
Owner-occupied property operation			
Professional, scientific, technical, administrative and support services			
Public administration, defence, and safety		Y	Y
Education and training	Y	Y	Y
Health care and social assistance			Y
Other services			Y
Estimated share of output that can be picked up at other times	75%	50%	25%
Estimated share of output that is subject to output lost	25%	50%	75%

Notes:

1. An “Y” denotes an industry that are likely to face output lost due to reduced work hours during the storm period.
2. The estimated shares of output that are subject to output lost are based on Wellington regional GDP share in 2009/10 and are rounded to the nearest 5%.

A5.4 Estimated value of output loss due to reduced work hours

Based on different assumptions around the share of output lost that could be temporary in nature, the value of output loss due to reduced work hours over the storm period (21-26 June 2013) is estimated at between \$1.68 million and \$5.03 million, with a mid-range estimate of \$3.35 million (see Table A4).

Table A4: Estimated value of output loss due to reduced work hours

Storm affected days	Estimated total number of work hours lost E	Estimated output loss due to reduced work hours (\$ million)		
		Low	Mid-range	High
		F = E * temporary output lost adjustment * \$20.94 per hour		
Friday (21 June 2013)	199,756	\$1.05	\$2.09	\$3.14
Monday (24 June 2013)	51,656	\$0.27	\$0.54	\$0.81
Tuesday (25 June 2013)	40,126	\$0.21	\$0.42	\$0.63
Wednesday (26 June 2013)	28,597	\$0.15	\$0.30	\$0.45
Total		\$1.68	\$3.35	\$5.03

Note: Figures may not sum to totals due to rounding.

A6. Cost of increased travel time

Transport disruptions during the Wellington Storm not only affected the total number of hours worked, they also affected the total travel time taken. For commuters and other non-work travellers, this means their leisure time was shortened during that period. For business travellers, the extra traffic delays added costs to business. These effects are measured by estimating the change in the value of total travel time. Equation 5.3 describes the formula for estimating the value of travel time due to increased delays.

$$\left[\begin{array}{c} \text{Cost} \\ \text{of} \\ \text{increased} \\ \text{travel} \\ \text{time} \end{array} \right] = \left[\begin{array}{c} \text{Estimated} \\ \text{number of} \\ \text{travellers} \\ \text{(by car or PT)} \\ \text{on a typical} \\ \text{working day} \end{array} \right] * \left[\begin{array}{c} \text{Estimated} \\ \text{percentage} \\ \text{of travellers} \\ \text{did travel} \\ \text{on the} \\ \text{storm affected} \\ \text{days} \end{array} \right] * \left[\begin{array}{c} \text{Weighted} \\ \text{average} \\ \text{increase in} \\ \text{travel time} \\ \text{during the} \\ \text{storm affected} \\ \text{days} \end{array} \right] * \left[\begin{array}{c} \text{Weighted} \\ \text{average} \\ \text{value of} \\ \text{travel time} \end{array} \right] \quad (5.3)$$

According to GWRC's transport model, there are on average 213,020 peak hour travellers by car or by public transport. The model also indicated that peak hours traffic is made up of 39% commuting trips, 9% work related trips and 53% others (eg education or shopping).

Estimates of value of travel time (expressed in 2012 dollars) are sourced from the NZ Transport Agency's Economic Evaluation Manual. They were adjusted upward to 2013 dollars assuming a 2% inflation. The resulting value of travel time estimates are \$10.90 per hour for commuting trips, \$33.32 per hours for work related trips and \$9.64 per hour for other trips. Using the shares of trips by trip purpose, the weighted average value of travel time was estimated at \$12.19 per hour.

As noted in Section 5.2, around 27.1% of the respondents did not go to work as intended due to transport disruptions on Friday (21 June 2013), and 3.6% on Monday (24 June 2013) and 2.3% on Wednesday (26 June 2013). Because the storm survey focused on commuting and work related travel arrangement, it is unclear whether there was a similar level of reduction in the amount of travel for other purposes during the storm affected days. Due to a lack of information, it has been assumed that the reduction in the amount of travel for trip purposes other than commuting or work was the same as that for commuting and work related trips.

Data collected from the storm survey shows that the weighted average morning-peak travel time was 0.33 hours longer than a typical working day on the Friday the 21st of June 2013. This average delay reduced to 0.31 hours on Monday (24 June 2013) and to 0.23 hours on Wednesday (26 June 2013).

Using equation 5.3, the estimated cost of increased travel time during morning-peak is summarised in Table A5. Again, the estimate for Tuesday was derived by interpolation.

Table A5: Estimated cost of increased travel time (morning-peak)

Storm affected days	Share of travellers did not travel as intended	Weighted average increase in travel time (hours)	Estimated increase in total travel time	Cost of increased travel time \$ million
	A	B	$C = 213,020 * (1 - A) * B$	$D = C * \$12.19$
Friday (21 June 2013)	27.1%	0.329	51,101	\$ 0.62
Monday (24 June 2013)	3.6%	0.309	63,462	\$ 0.77
Tuesday (25 June 2013)		interpolated		\$ 0.68
Wednesday (26 June 2013)	2.3%	0.230	47,969	\$ 0.58
Total				\$ 2.66

Note: Figures may not sum to totals due to rounding.

As the storm survey focused on travel time required for getting to work, the additional delays during inter-peak and evening-peak cannot be determined. If the combined cost of increased travel time during other time periods is the same²⁷ to that of the morning-peak, the total cost of increased travel time would be in the order of \$5.32 million.

²⁷ There is no basis for this assumption. However, it can be expected that inter-peak travel would be less congested than that during the morning-peak. Therefore, any additional delays during inter-peak would be lower than that of the morning-peak. For evening-peak travel, it can be expected that travellers would alter their travel time to minimise delays. Therefore, it is reasonable to assume the value of additional delays during inter-peak and evening-peak would both be lower than that for the morning-peak.

A7. Economic impacts – gross output approach

The total economic impact from any economic shock includes not only its direct and indirect effects, but also its induced effects. The direct effect consists, for instance, in the number of direct jobs the economic shock affects, and the indirect effects could consist of jobs affected down the supply chain. An induced effect consists of the impact of spending by the workers affected. For instance, an increase in activity in one part of an economy can increase the total earnings of the workers (of the concerned industry as well as the rest of the supply chain). Workers can then spend their additional earnings on local goods and services, thereby providing a boost to the local economy. The contrary occurs when there is a contraction in economic activity.

One way economists use to measure total economic impact is to trace the course of spending through an economy and find out the total effect of that spending. This can be carried out using an input-output table based analysis, which assesses the inter-dependencies between different branches of an economy and shows how output from one industrial sector may become an input to another industrial sector. Under the input-output approach, indirect and induced effects are estimated through the use of multipliers.

An input-output analysis was carried out to estimate the economic impacts of transport disruptions resulting from the Wellington Storm. As Statistics New Zealand does not publish regional input-output tables, the analysis was based on the national input-output table²⁸. To account for the differences in the industry mix between the Wellington region and the national economy, the national multipliers were applied to Wellington's industry GDP estimates for 2010 (the latest regional GDP available). The analysis was based on the premise that the transport disruptions resulted from the Wellington Storm affected final demands mainly through contractions in the levels of private consumption spending and exports during the storm affected days.

Considering the proportion of travellers did not go to work as intended (discussed in Section 5.2) and the temporary output loss adjustment (discussed in Section 5.3), the input-output analysis suggested that the direct output loss was \$5.66 million for Friday (21 June 2013), \$0.75 million for Monday (24 June 2013) and \$0.47 million for Wednesday (26 June 2013) (see Table A6). These estimates are higher than those estimated based on the estimated reduction in the number of hours worked (see Table A6). This is because the gross output approach included effects on intermediate consumptions and gross domestic products and not just the production lost and the welfare approach excluded the effects from those who worked from home during that period.

Table A6: Estimated economic impacts of transport disruption resulting from the Wellington Storm – Gross output approach (mid range estimate)

Storm affected days	Direct effects \$million	Indirect effects \$million	Induced effects \$million	Total effects \$million
Friday (21 June 2013)	5.66	4.45	6.16	16.27
Monday (24 June 2013)	0.75	0.59	0.82	2.16
Tuesday (25 June 2013) (note)	0.61	0.48	0.66	1.75
Wednesday (26 June 2013)	0.47	0.37	0.51	1.35
Total	7.49	5.89	8.15	21.53

Notes:

1. Estimates for Tuesday (25 June 2013) were derived using interpolation.
2. Figures may not sum to totals due to rounding.

²⁸ The latest national input-output table available is for 2007.

Using the national multipliers and adjusting for Wellington’s industry mix, the indirect and induced effects were added to the direct effects to derive the total effects (see Table A6). The estimated total economic impacts range from \$10.76 million to \$32.29 million, with a mid-range estimate of \$21.53 million (see Table A7).

Table A7: Estimated economic impacts of transport disruption resulting from the Wellington Storm – Gross output approach

Storm affected days	Estimated total gross output effects \$ million	Estimated reduction in Wellington GDP for the four working days affected by the storm (21-26 June 2013) %	Estimated reduction in annual Wellington GDP %
Low	10.76	-2%	-0.02%
Mid-range estimate	21.53	-4%	-0.05%
High	32.29	-6%	-0.07%

Note: Estimates of share of economic impacts as a percentage of Wellington GDP was derived using the estimated national shares of intermediate consumption and gross domestic product in gross output of 47% and 53% respectively.

Input-output analysis assumes that input proportions between different economic sectors are fixed and do not change significantly in the short-term. As a result, results calculated by this method should be regarded only as approximations and they are more likely to give an idea about the magnitude of the impacts, rather than their specific amounts.

Further, national GDP has increased by 11.2% over the three years to 2013 but the increase for the Wellington region over that period is unknown. Therefore, it may be more informative to look at the estimated percentage changes in GDP instead of the changes in gross output in dollar terms. Results show that the economic impacts of the Wellington Storm were relatively low (between -0.02% and -0.07% of annual GDP for the Wellington region).

A8. Summary and conclusion

This report looks at the economic impacts of transport disruptions resulting from the storm occurred in Wellington in June 2013. The analysis adopted two approaches – the welfare approach and the gross output approach. The mid-range estimates are summarised in Table A8 below.

Table A8: Economic impacts of transport disruption resulting from the Wellington Storm – mid-range estimates

Economic impact component	Welfare approach		Gross output approach with welfare impacts added	
	<i>Cross-reference</i>	\$ million	<i>Cross-reference</i>	\$ million
Additional communications cost	<i>Section A2</i>	\$0.041	<i>Section A2</i>	\$0.041
Costs of provision of bus replacement services	<i>Section A3</i>	\$0.200	<i>Section A3</i>	\$0.200
Cost of remediation and restoration to transport infrastructure	<i>Table A1</i>	\$5.080	<i>Table A1</i>	\$5.080
Output loss	<i>Table A4</i>	\$3.352		n/a
Gross output impacts		n/a	<i>Table A7</i>	\$21.530
Value of increase travel time	<i>Section A6</i>	\$5.321	<i>Section A6</i>	\$5.321
Total – mid-range estimate		\$13.994		\$32.171

Note: Figures may not sum to totals due to rounding.

According to the welfare approach, the total economic cost of transport disruptions resulting from the Wellington Storm was estimated at between \$12.3 million and \$15.7 million, with a mid-range estimate of \$14.0 million (see Table A9). The variation in the estimate was due to the uncertainty around the degree to which the level of output lost due to reduced work hours was permanent and whether such losses could be recaptured at subsequent periods.

Table A9: Economic impacts of transport disruption resulting from the Wellington Storm – sensitivity analysis

Scenario	Welfare approach	Gross output approach with welfare impacts added
	\$ million	\$ million
Low	\$12.3	\$21.4
Mid-range	\$14.0	\$32.2
High	\$15.7	\$42.9

As the welfare approach did not look at the inter-linkages between industries and any indirect or induced effects, the analysis also used the gross output approach to estimate the overall economic impacts of the event. Results show the gross output impact of transport disruption resulting from the Wellington storm was between \$10.8 million and \$32.3 million, with a mid-range estimate of \$21.5 million (see Table A7). These economic costs are additional to the immediate costs of managing the transport disruption (estimated at \$5.3 million) and the value of increased travel time to travellers (also estimated at \$5.3 million). Therefore, the total economic costs would be in the order of between \$21.4 million and \$42.9 million, with a mid-range estimate of \$32.2 million (see Table A9).

Considering both the welfare and the gross output approaches, the overall economic impact of transport disruption resulting from the Wellington Storm was estimated at between \$12.3 million (low-end estimate of the welfare approach) and \$42.9 million (high-end estimate of the gross output approach). Although there are considerable uncertainties around these estimates, results show that the overall impact is relatively small comparing to the size of the Wellington economy of around \$27 billion GDP per annum. This result indicates Wellington's transport network is highly resilient in responding to small scale natural disasters such as the Wellington Storm.

Appendix B

Notes about the Ministry of Transport survey

Survey forum: online via Survey Monkey, with recruitment via social media requesting respondents from the wider Wellington region. The survey link was posted to various locations, and respondents were invited to pass the link on to friends, family and work colleagues. Particularly good response numbers were obtained via posting to the Wellington Regional Emergency Management Office's Facebook page and through contacts at the Capital and Coast District Health Board.

Respondents: 1,072 (1,005 public and 67 internally from the Ministry of Transport), of which 1,056 completed enough of the survey to analyse.

There were 2,011 clicks of the public survey link, so therefore a response rate of 50% by those who followed the link. It is unclear the total number of people who will have seen the link in the first place, and not followed it, so the total response rate will be somewhat lower.

Of those who started the survey, 895 finished it, with 177 giving incomplete responses.

Respondents were given the option of specifying their area of residence as:

- Upper Hutt
- Lower Hutt
- Porirua
- Wellington City
- Other (please specify).

Based on these responses, the following origin areas were used, based on the rail lines fed into:

- Hutt: Hutt Valley, Stokes Valley, Wainuiomata, Eastern Hills, Wairarapa
- Kapiti: Tawa, Porirua, Kapiti Coast
- Other: Wellington City (excluding where Tawa specified).

Table B1: Survey sample sizes by area

	Sample sizes
Hutt	318
Kapiti	180
Other	558
Total	1056

Table B2: Survey sample size of those who knew about transport delays ahead and if they changed their travel plans based on this

Number of people who:	Friday 21 June	Monday 24 June	Wednesday 26 June
Knew of transport delays ahead of time	787	805	724
Changed their travel based on this	447	314	242

Table B3: Survey sample size for those who knew about transport delays ahead and how they found out

		Friday 21 June	Monday 24 June	Wednesday 26 June
How they found out (multiple options allowed)	Those who knew ahead	787	805	724
	Radio	389	394	356
	TV	142	179	171
	Newspaper	34	87	93
	Direct notification	166	155	132
	Official website	201	218	185
	Social media	222	207	175
	Internet (other)	242	259	214
	Other	75	35	25

Table B4: Typical train users and how they knew ahead

	Train users		
	Friday 21 June	Monday 24 June	Wednesday 26 June
Typical train users who knew about delays ahead	224	237	234
Radio	35%	37%	35%
TV	13%	16%	15%
Newspaper	1%	5%	10%
Direct notification	51%	46%	41%
Official website	32%	39%	36%
Social media	27%	25%	24%
Internet (other)	23%	25%	24%
Other	9%	3%	2%

Table B5: Survey sample size of those who intended to work, if they couldn't and if they worked from home, by day

		Total	Hutt	Kapiti	Other
Friday 21 June	People who intended to work	947	286	163	498
	Didn't travel to work	257	110	59	88
	Worked from home	116	59	19	38
Monday 24 June	People who intended to work	973	295	167	511
	Didn't travel to work	35	14	4	17
	Worked from home	16	11	1	4
Wednesday 26 June	People who intended to work	930	282	163	485
	Didn't travel to work	16	11	1	4
	Worked from home	11	9	0	2

Table B6: Survey sample size by main travel mode

		Drive (private)	Passenger (private)	Train (or bus replacement)	Public bus	Walk or jog	Bicycle	Others	Total
Hutt	<i>Typical</i>	105	23	163	16	0	7	7	321
	Fri 21 June	106	33	24	15	0	0	1	179
	Mon 24 June	134	49	64	24	0	7	7	285
	Weds 26 June	127	41	65	20	0	7	9	269
Kapiti	<i>Typical</i>	87	12	82	1	0	2	2	186
	Fri 21 June	74	18	10	2	0	0	1	105
	Mon 24 June	77	17	63	2	0	2	2	163
	Weds 26 June	68	15	72	2	0	1	2	160
Other	<i>Typical</i>	211	32	33	140	100	34	15	565
	Fri 21 June	183	50	4	110	55	7	6	415
	Mon 24 June	199	34	23	126	76	25	10	493
	Weds 26 June	185	32	22	123	73	24	12	471
Total	<i>Typical</i>	403	67	278	157	100	43	24	1072
	Fri 21 June	363	101	38	127	55	7	8	699
	Mon 24 June	410	100	150	152	76	34	19	941
	Weds 26 June	380	88	159	145	73	32	23	900

Table B7: Sample of people who travelled to work and if they used a different mode to their usual one

	Friday 21 June	Monday 24 June	Wednesday 26 June
Travelled to work	690	939	908
Used a different mode to usual	202	177	147
% of people who changed from their usual mode by usual mode:			
Private vehicle:			
Drove	5%	4%	5%
Passenger	16%	16%	11%
Bus	25%	14%	11%
Walk/Jog	37%	18%	14%
Other	79%	22%	14%
Train	73%	42%	37%

Table B8: Hutt rail commuters and their transport mode choices

Typical Hutt train commuters mode choices	Friday 21 June	Monday 24 June	Wednesday 26 June
Sample number who travelled to work that day	67	143	139
Drove	36%	27%	29%
Passenger	19%	19%	15%
Bus	12%	7%	7%
Other	1%	3%	3%
Train	31%	44%	46%

Table B9: Sample size of people delayed in getting to work by area on Friday 21 June

Friday 21 June Area	Longer than usual getting to work?				Total
	No	<1/2 hr	1/2-1 hr	>1 hr	
Hutt	43	42	47	46	178
Kapiti	43	33	16	11	103
Other	229	136	34	11	410
Total	315	211	97	68	691

Table B10: Sample size of people from the Hutt area - delays and departure times for Friday 21 June

Hutt - Friday Change departure time?	Longer than usual getting to work?				Total
	No	<1/2 hr	1/2-1 hr	>1 hr	
Yes, I left earlier than usual	21	18	27	24	90
No	18	14	12	11	55
Yes, I left later than usual	4	10	8	11	33
Overall	43	42	47	46	178

Table B11: Sample size of people delayed in getting to work by area on Monday 24 June.

Monday 24 June		Longer than usual getting to work?			
Area	No	<1/2 hr	1/2-1 hr	>1 hr	Total
Hutt	55	69	71	90	285
Kapiti	88	50	21	4	163
Other	350	108	30	0	488
Total	493	227	122	94	936

Table B12: Sample size of people from the Hutt area - delays and departure times for Monday 24 June.

Hutt - Monday		Longer than usual getting to work?			
Change departure time?	No	<1/2 hr	1/2-1 hr	>1 hr	Total
Yes, I left earlier than usual	24	47	48	54	173
No	29	17	16	28	90
Yes, I left later than usual	2	5	7	8	22
Overall	55	69	71	90	285

Table B13: Sample size of people delayed in getting to work by area on Wednesday 26 June.

Wednesday 26 June		Longer than usual getting to work?			
Area	No	<1/2 hr	1/2-1 hr	>1 hr	Total
Hutt	62	77	87	41	267
Kapiti	110	33	13	4	160
Other	374	73	13	5	465
Total	546	183	113	50	892

Table B14: Sample size of people from the Hutt area - delays and departure times for Wednesday 26 June.

Hutt - Wednesday		Longer than usual getting to work?			
Change departure time?	No	<1/2 hr	1/2-1 hr	>1 hr	Total
Yes, I left earlier than usual	16	41	61	34	152
No	46	24	17	5	92
Yes, I left later than usual	0	12	9	2	23
Overall	62	77	87	41	267

Comments were collected as free text as part of the survey. These responses are available to select agencies upon request.

Appendix C

Press releases about expected delays Monday 24 June²⁹

Kiwirail

Disruption to Hutt Valley and Wairarapa train lines this week.

KiwiRail is advising Hutt Valley Line and Wairarapa Line train commuters to EXPECT AND PLAN FOR LONGER THAN USUAL TRAVEL TIMES into Wellington City this week, as a result of significant damage to rail tracks in Petone during last week's storm.

"The track damage means no trains will be able to run between Petone and Wellington until repairs are completed and all train services between Petone and Wellington will need to be bus replaced until further notice. From tomorrow morning's peak, a special half hourly timetable will run on the Hutt Valley Line with trains running between Upper Hutt and Petone until further notice. The Wairarapa line will also be affected and some services will be cancelled and some will be bus replaced," Tranz Metro Manager Scott Brooks.

The reduced train services and bus replacements is likely to increase traffic congestion and commuters are being urged to prepare for this and to expect their commuting time to be longer than usual this week. There will also be no parking on Hutt Road, south of the Petone Railway Station, which will be utilised as a bus parking layby for the train replacement buses.

KiwiRail is working with NZ Police, New Zealand Transport Agency and Wellington Regional Emergency Management Office in an effort to minimise the disruption to commuters.

NZ Police Hutt Valley Area Inspector Mike Hill is urging commuters to consider carpooling if they decide to travel by car into Wellington City.

"We would like commuters to plan ahead so they leave plenty of time to get to their destination, drive to the conditions and be patient. People should expect some congestion on the roads, particularly around Petone, and if travel is urgent, it might be wise to look at alternative means of transport. If you can carpool with others, this is a good way to ease traffic congestion," Inspector Hill says.

Mr Brooks says KiwiRail Infrastructure and Engineering staff have been working around the clock since the storm to ensure that repairs are completed as quickly as possible to minimise any longer term disruption to Hutt Valley and Wairarapa Line commuters. However, in some places the ballast has been completely washed away, and it will take time for repairs to be finished.

Tranz Metro has put a special timetable for the Hutt Valley Line and the Wairarapa Line on their website and is urging customers to check the website before they travel at www.tranzmetro.co.nz.

²⁹ From <https://www.facebook.com/WREMONz?fref=ts&filter=1> 24 June 2013, accessed 21.8.2013

“As we have more information we will update customers but for the foreseeable future customers should plan their travel around the special timetable,” says Mr Brooks.

NZTA

Traffic Advisory for Monday 24 June³⁰

PLAN AHEAD FOR DELAYS ON WELLINGTON HIGHWAYS TOMORROW

The NZ Transport Agency advises motorists to plan ahead for likely delays on Wellington's highway network tomorrow (Monday 24 June) due to disruption to train services following last week's ferocious storm.

NZTA Central Operations Manager Mark Owen says reduced train services are likely to mean the roads are more congested during peak hour than normal, and motorists should plan their journeys to help reduce disruption. The Hutt Valley and Wairarapa train lines are affected, but this is expected to have flow-on congestion for other travellers getting in and out of Wellington.

Mr Owen says the NZTA were encouraging motorists to travel outside peak hour if possible. Carpooling and working from home would also help to keep numbers on the road to manageable levels

"Wellington is still recovering from its biggest storm in decades, so it's not surprising that there's some disruption as KiwiRail works hard to get train services fully restored. We're expecting quite a manic Monday, so we urge motorists to think about how and when they intend to travel tomorrow, and plan ahead. If people can tweak their usual travel plans, it's likely to mean reduced time on the road for themselves and others."

He says motorists with tight travel deadlines, such as shift workers and airport travellers, will need to allow themselves plenty of leeway to make sure they get to their destinations on time.

Mr Owen says the NZTA, along with partners Wellington City Council, would be monitoring traffic levels closely from Wellington's Traffic Operations Centre, and will be updating electronic information signs and issuing traffic alerts to keep motorists informed in real time. The NZTA would be working closely with NZ Police, KiwiRail and local authorities to keep traffic moving and well informed.

Mr Owen says the NZTA thanks motorists for their patience and understanding.

³⁰ <http://www.nzta.govt.nz/traffic/current-conditions/bulletin/2659/news.html> accessed 21.8.2013