WHAKARATONGA IWI

FIRE EMERGENCY NEW ZEALAND

Traffic Calming and effective response speeds

Prepared for Fire and Emergency New Zealand by MRCagney (NZ) Ltd.

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Traffic calming and effective response speeds

Final Report

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Executive Summary

Over the past few years, how government and local authorities think about the transport system in New Zealand has shifted from being primarily automobile centred to being inclusive of all road users. With these changes in priorities, comes changes in how the road network is managed. Gone are the days of trying to move as many automobiles as possible as quickly as possible. Instead, Waka Kotahi and Auckland Transport have strategies in place to reduce speeds and increase safety – especially of vulnerable road users. This strategy is apparent with the adoption of Waka Kotahi's "Road to Zero" and Auckland Transport's "Vision Zero".

Of course, any change to the way society functions comes with costs and benefits. Some are obvious, such as reduced deaths being a benefit and any increased travel times being costs. However, there are other, less obvious, costs and benefits. One that is of particular interest to Fire and Emergency New Zealand (FENZ) is how these changes to the roading network may impact on FENZ's ability to access sites and FENZ's emergency response speeds, access and times. This is a reasonable concern as society expects to be attended to quickly when experiencing an emergency and there is ample evidence that longer emergency response times lead to worse outcomes for people, property, and the environment.

This report is a first look at how emergency response may be impacted by changes to roading strategies and priorities. It includes a review of relevant literature, a qualitative analysis of traffic calming interventions, and a quantitative analysis of a case study where a traffic calming strategy has already been implemented.

Literature review

The literature examining the impact of traffic calming and roading network changes on emergency response is quite thin – especially given the importance society places on timely emergency response and the risk to life, property, and the environment from delayed emergency response. Most of the professional guidance on traffic calming and roading network changes recommends that road designers consider the impact on emergency response times. However, there is little real-world quantitative information to inform decision-making. Only a small handful of relevant studies were identified which fall into one of two categories.

First are those studies which look at the impact of interventions like speed humps in a controlled environment. In one oft-cited study, emergency appliances were driven down two roads – one with speed humps and one without – and the speeds and times compared. This study found that speeds were slower on the road with speed humps. And, while this is potentially useful information, it does not reflect real-life conditions as roads are not usually devoid of traffic and other users.

Next, are studies which look at emergency response before and after interventions are put in place. In theory, these studies should be able to isolate the impact of interventions on emergency response times in real-world conditions. One study from the UK found that there appeared to be no net impact on emergency response times in areas where "low-traffic neighbourhoods" had been implemented when compared to areas where they had not. And while this study is promising, it is essentially the only ex post study of traffic calming interventions on emergency response.

In isolation, common sense and a handful of studies have shown that traffic calming can theoretically slow emergency response. However, these studies generally do not represent real-world conditions. There is also no publicly available research that investigates the cumulative impact of interventions – it is not as simple as saying that if one speed hump causes 10 seconds of delay, then six speed humps cause 60 seconds of delay. It could be more, or it could be less.

In summary, there is just not much evidence one way or another on how emergency response is impacted by traffic calming in real-world conditions. This does, however, present an opportunity for FENZ and Auckland Transport to be leaders in this area. If trials were conducted and proper data collected, it could help inform the

right decisions for not only Auckland and New Zealand, but also other jurisdictions world-wide facing the same questions.

Quantitative assessment

Using data from FENZ, Auckland Transport, and Stats NZ, we performed a quantitative analysis of the trends in emergency response times in Auckland. In general, the effective speed (the crow-fly distance divided by time) of emergency response has slowed through time, irrespective of any traffic calming initiatives or strategies. Across all of Auckland, the average effective speed has dropped steadily from approximately 30.9 kph at the beginning of 2016 to about 28.7 kph in mid-2022. Given an average callout distance of 2.11 km, this means that from 2016 to mid-2022, an average distance callout would take approximately 19 additional seconds from the time the appliance leaves the station until it arrives at the scene.

We also examined a case study to see if an area with a dedicated strategy of traffic calming experienced a larger change in effective response speeds than would have been expected if there had been no traffic calming. Unfortunately, examples of this in Auckland are (at this point in time) few and far between. One exception is Auckland Transport's Residential Speed Management programme which has already been implemented in one area of Manurewa.

We found that in this area of Manurewa, there does not appear to be a statistically significant difference in effective response speeds before and after the traffic calming interventions were put in place. Yes – speeds from the Manurewa fire station have gotten slower, but this is true whether callouts were headed to an area with traffic calming strategies in place or not. So, while this is a promising finding, it represents a small fraction of Auckland (a callout area of about 7.5 km^2).

Qualitative assessment

We also undertook a qualitative assessment of the issues FENZ had identified as main areas of concern. The analysis is based on the literature review, FENZ submissions to Auckland Transport, advice and information received from Auckland Transport and Waka Kotahi representatives, and best practice technical guidance on traffic calming from various local and international sources.

The assessment describes each concern, provides analysis of the relevant issues, and concludes with recommendations. Highlighted concerns include the impact that some of the following have on response times: traffic calming, increased density, removal of minimum parking requirements and reduced speed limits.

The results of this assessment indicate that there is a lack of evidence around some of the key concerns that have been identified by FENZ. The section outlines recommendations around how this could be addressed including the need for better data collection and opportunity for further research. In order to achieve good outcomes, there will be a need to rely on first principles and a strong partnership with AT.

Summary and recommendations

The existing literature on how emergency response is impacted by traffic calming interventions is quite thin and not convincing one way or another. While FENZ has legitimate concerns about how Auckland Transport and Waka Kotahi's changes in roading strategies will affect emergency response, there is limited data available to determine if emergency response access and speeds are likely to be affected. In addition, the submissions process does not seem to be resolving concerns in a way that is deemed adequate by either FENZ, or the roading authorities.

One of the initial purposes of this work was to review existing literature and examine data from Auckland to help determine which traffic calming interventions were likely to have the most impact on FENZ. However, the sparse existing literature and the lack of adequate data make this a currently infeasible task. Because of this, we recommend that FENZ and the roading authorities engage in dialogue around this topic.

Due to the level of uncertainty on how specific interventions (or combinations of interventions) are likely to impact response times, we recommend that FENZ and Auckland Transport work together to install pilot/test cases. It should be reasonably straightforward for FENZ and the roading authorities to actively monitor the impact of traffic calming and other roading strategy changes on emergency response times when these trials are set up. This would place New Zealand at the forefront of the research on this topic and give FENZ, Waka Kotahi, and Auckland Transport worldwide expertise on a little-studied subject.

For policies that are not traffic calming interventions (for example, parking management reform), FENZ should continue to advocate for those policies that will increase access and response times.

Ultimately, dealing with the changing face of Auckland's (and New Zealand's) roading infrastructure will require both short- and long-term strategies by FENZ and the roading authorities. In the short-term, how existing appliances interact with changes to the roading network needs to be worked out. There could be changes to appliance maintenance or how appliances are used. There could also be temporary modifications to the roading strategy to accommodate the legacy FENZ fleet. In the long-term, FENZ will likely need to adjust the types of equipment that is procured to ensure that it is more manoeuvrable and adaptable to the changes to New Zealand's cities and roads.

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Glossary

Term	Meaning
AT	Auckland Transport
CPMP	Comprehensive Parking Management Plans
FENZ	Fire and Emergency New Zealand
LTN	Low Traffic Neighbourhood
MRC	MRCagney
NACTO	National Association of City Transportation Officials
NPS-UD	National Policy Statement on Urban Development
PT	Public Transport
SA2	Statistical Area, Level 2
TDM	Auckland Transport's "Transport Design Manual"
VKT	Vehicle Kilometres Travelled

1 Introduction

Across the globe, cities are changing as populations continue to grow and climate change becomes a pressing issue. The world population is approaching 8 billion people, with nearly 60% of the population living in cities. In New Zealand, the population has grown from 3 million in the mid-1970s to more than 5.1 million in 2022. However, in Auckland, the population growth has been even quicker, with the estimated population increase from about 700,000 in the mid-1970s to 1.7 million today.

All those people moving to Auckland brought their cars with them, increasing traffic congestion. The Automobile Association suggests that the average peak-hour motorway user in Auckland lost 95 hours to congestion in 2019[1].

The shape of the city is also changing. Auckland's Unitary Plan, which became operative in late 2016, resulted in significant changes to zoning rules. Relaxed rules around density and multi-unit development mean that up to one million[2] additional dwellings can be added to Auckland's existing urban form – on top of a housing stock of approximately 550,000 dwellings at the 2018 census.

No longer does population growth mean an expansion of the city's urban boundary. Instead, existing areas are becoming denser, with many examples of standalone dwellings being razed and replaced with multiple townhouses or even apartment units. Along with these density rules, many other rules have changed around associated considerations, such as minimum parking requirements.

In response to these shifts in how Auckland accommodates population growth, Auckland Transport (AT) has embarked upon changes to the roading and wider transport network. The roads and public transport (PT) that were effectively serving a city largely made of standalone dwellings on reasonably large pieces of land are inadequate for a denser, more compact modern city.

At the same time, Waka Kotahi has embarked upon their "Road to Zero" campaign[3], with a goal of zero serious injuries and deaths on the roads of New Zealand by 2050. This includes all transport system users i.e., walkers, cyclists, drivers, motorcyclists, and PT users. A large part of this initiative is keeping speeds survivable. That means, in the event of a crash, it is likely that those involved will survive. On city and suburban streets, this means a speed of 30 to 40 kph.

To accomplish these speeds, AT and Waka Kotahi have introduced various initiatives such as the Residential Speed Management programme. Many of the things that keep speeds low are what are known as vertical traffic calming devices. These types of interventions include speed bumps, speed humps, speed cushions, raised tables, and raised zebra crossings.

For Fire and Emergency New Zealand (FENZ), these changes are meaningfully impacting how emergency services are delivered. Auckland is growing quickly – even with the pandemic pause – and simultaneously becoming denser. The patterns of development have changed considerably over the past few years meaning that strategies to deliver emergency services to an area may need to be adjusted going forward.

There has also been an increased push on road safety for all users as opposed to a previous focus on making roads as quick and easy as possible for automobiles. Changes to the status quo always necessitate an adjustment, and in this case, FENZ needs to determine how operations could be impacted by changes to roading infrastructure strategies.

[1] https://www.documentcloud.org/documents/20501225-aa-auckland-congestion-report-2020-updated-draft

[2] https://www.aucklandcouncil.govt.nz/about-auckland-council/business-in-auckland/docsoccasionalpapers/reality-check-impact-zoning.pdf

[3] https://www.nzta.govt.nz/safety/what-waka-kotahi-is-doing/nz-road-safety-strategy/

Separate from this, the nature of FENZ emergency response has expanded – meaning that even without the growth, FENZ presence on the roads would be increasing through time.

All these things put together impact how FENZ delivers emergency services in Auckland. Given the connection between how quickly and effectively FENZ can respond to emergencies and the trust that communities place in FENZ, it is vital to better understand the relationship between all the changes happening in Auckland and the ability to deliver emergency services.

Consequently, FENZ approached MRCagney (MRC) to investigate this issue. While there are many areas of concern, the five main themes various concerns can be categorised into are:

1. Traffic calming (e.g., speed humps, road narrowing)
2. Traffic congestion
3. Reducing speed limits
4. The impact on site access that the removal of minimum parking requirements may have
5. Other changes to transport strategy that impact FENZ operations (such as light rail and rail crossings)

1.1 Research Strategy

To do an analysis of these policies and interventions, we liaised primarily with FENZ and AT with some brief discussions with Waka Kotahi. FENZ provided data on appliance operation, academic literature, and copies of their submissions on various proposals from the past several years.

From AT, we obtained (limited) information on where traffic calming measures have been installed, a dataset of vehicle counts, and insights into the rationale for the interventions.

We have also collected other publicly available data from various sources to contribute to our overall analysis including from academic literature.

1.2 Report Structure

This report provides three specific angles of analysis.

- Section two is a summary of the academic literature, both primary and secondary, and the FENZ submissions. This includes commentary and context of what was provided by FENZ and AT to MRC.
- Section three details several quantitative assessments which relate changes in FENZ effective response speeds to changes in traffic calming and traffic congestion.
- Section four is a qualitative assessment of the areas of concern for FENZ. This section describes interventions and notes the potential positive and negative effects on FENZ.

The report concludes with two sections. Section five highlights future research areas that may be beneficial to FENZ. Finally, section six provides a summary of recommendations and a brief conclusion.

2 Summary of Existing Literature and FENZ Submissions

At the outset of this project, FENZ provided academic literature and professional guidance on emergency services and roading network changes, as well as copies of submissions that FENZ has made on roading projects in Auckland. This section provides a brief overview of the recurring themes from these documents, as well as additional information obtained from other sources during the literature review process.

2.1 Existing literature on traffic calming and emergency response

There is shockingly little research on the intersection of emergency services and changes to roading networks and policies – especially given the importance of emergency response to society. Further, of what exists, little of it is of high quality and much of it is not primary research, but citations of other previous studies or guidance that has recommendations but without supporting evidence. Additionally, it is very difficult to isolate the impact of traffic calming measures specifically have on response times given all the other variables in real-life traffic patterns.

This section summarises the primary research, pulls out key themes, and makes recommendations on how this literature can be used to support FENZ's discussions on traffic calming.

2.1.1 Primary research on traffic calming and/or emergency response

As stated above, there is little primary research on how traffic calming impacts the speed of emergency services. However, there are a small number of studies that investigate how traffic calming directly or indirectly might impact emergency services. These studies could provide insight to FENZ submissions and areas in which to focus discussions with Waka Kotahi and AT.

"The Influence of Traffic Calming on Emergency Response Times", US (1997)

This is an oft-cited study[4] of the impact of traffic calming devices on emergency services. The study area was Portland, Oregon USA where, in 1995, "the city performed a research project to measure the affects (sic) of both traffic circles and speed bumps on response times for various types of fire apparatus".

Six streets were used to test the time impacts that speed bumps and traffic circles have on emergency vehicles. The authors determined that four variables in their study could influence speed delays: the driver, the vehicle, the desirable speed, and the traffic calming meausure. The tests were performed using six different appliances driven four times each down each of the six streets using 36 different drivers. Two of the streets had 14 foot (4.25 metre) speed bumps, two had 22 foot (6.7 metre) speed bumps, and two had traffic circles. Speed was measured using a speedgun and a camera recorded the trials. Each measurement was compared to a baseline road with no interventions.

The study found that differences in drivers were insignificant. However, for each type of intervention, the time delays were dependent on how fast they wanted to be travelling and the different vehicles (which could be due to differences in weight and horse power). For each of the traffic calming devices studied, lower delays were seen with lighter vehicles and when the desired speed was lower (40 – 50

[4] Atkins, C., & Coleman, M. (1997). The Influence of Traffic Calming on Emergency Response Times. Institute of Transportation Engineers. ITE Journal, 67(8), 42-46.

kph). The 22 ft speed bumps had 0.0 to 9.2 seconds of delay per bump, the 14 ft speed bumps had 1.0 to 9.4 seconds of delay per bump, and traffic circles created delays between 1.3 and 10.7 seconds.

In summary, this research found that, in a controlled environment, 14 ft speed bumps, 22 ft speed bumps, and traffic circles have similar delay implications. It also demonstrated that larger, heavier vehicles tend to be slowed more than smaller, lighter ones.

It is likely that this study finds an upper bound of the impact of traffic calming devices. In a controlled test-drive scenario as described, there were no other vehicles on the road. This means that the delay experienced was relative to free-flow conditions, which is unlikely to represent real-world conditions much of the time.

"The Impact of 2020 Low Traffic Neighbourhoods on Fire Service Emergency Response Times, in London, UK" (2021)

This 2021 study[5] is one of the few post hoc analyses of traffic calming interventions on emergency services that we came across in our literature search. During 2020, many low-traffic neighbourhoods were installed across London. The authors wanted to assess whether these interventions have affected emergency response times. Additionally, they wanted to see whether there were any differences in routes that had camera enforced speed measures versus physical barriers like planter boxes.

The authors compared response times before and after the interventions were installed in areas with and without the interventions. They tested to see how the overall response times were affected and if the interventions impacted the share of response times that were more than six minutes.

In every area, including the areas with traffic calming interventions, the average response time decreased as did the number of responses after the cut off times. This finding did not differ between the different types of traffic calming interventions (physical versus cameras).

In areas with traffic calming interventions, the number of delays attributed to traffic calming increased. However, the authors found that this was offset by a decrease in delays attributed to other causes. The main finding is that the improvements to traffic flow from the traffic calming interventions balanced any slowing effects the traffic calming devices caused to emergency vehicles.

This study looked at LTNs that used physical interventions and those that used cameras and compared these areas to places with no interventions. However, it did not compare the two types of interventions to determine if their outcomes were meaningfully different from one another. This would have been a useful addition to this study and is probably something that could be done with access to the raw data from this study.

Another feature of this work is that it could be potentially replicated for Auckland if the right kinds of data were collected. The advantage of this study is that it implicitly controls for changes to traffic volumes and how traffic calming devices interact with the roading network to impact overall speeds.

"Assessing Traffic Calming Measures for Safe and Accessible Emergency Routes in Norrkoping City in Sweden", (2018)

This 2018 study[6] uses a literature review of the research on how different traffic calming measures affect emergency response. Then, the locations of traffic calming measures were placed in a GIS tool,

[5] Goodman, A., Laverty, A. A., Thomas, A., & Aldred, R. (2021). The Impact of 2020 Low Traffic Neighbourhoods on Fire Service Emergency Response Times, in London, UK. Findings. https://doi.org/10.32866/001c.23568

[6] Al-Haji, G. (2018). Assessing Traffic Calming Measures for Safe and Accessible Emergency Routes in Norrkoping City in Sweden. International Journal of Transport and Vehicle Engineering, 12(9), 872-876.

as well as the emergency services' primary emergency network, data from the Swedish traffic accident data, the availability of emergency services and a transport network model for Norrkoping City.

The assumptions around how much each traffic calming measure adds to response times were used to estimate how much total delay would be caused by traffic calming in aggregate. The authors then conclude that certain types of traffic calming measures have bigger impacts on total delay than others.

While this study is noteworthy for looking at how traffic calming measures work together in a network, the conclusion that certain devices have bigger impacts on the roading network and associated travel times than others is something of a tautology. That is, the findings indicate that certain devices have bigger impacts (in aggregate) than others, but this is based on the assumption that certain devices have bigger impacts (on their own) than others. Further, the degree to which the devices create delay are based on previous studies where we have questions about the applicability to the real-world traffic network (see commentary on The Influence of Traffic Calming on Emergency Response Times, US, 1997).

Because of these limitations, this study is probably not well suited as evidence that traffic calming measures cause delay. Like other studies, based on the methodology used, this work gives an idea of the upper bound of the impact of LTNs and traffic calming on emergency response times.

However, a noteworthy aspect of this study is the citation of studies[7] that showed that the number of people killed in traffic accidents increases with increasing emergency response time, which is not well documented elsewhere. At the very least, this aspect is valuable as it corroborates what common sense would tell us.

"Role of ambulance response times in the survival of patients with out-of-hospital cardiac arrest, UK", (2011)

One of the worries about traffic calming interventions is that they will increase emergency response times. This is based on the observation that survival rates of those experiencing an emergency are higher when emergency crews arrive sooner. This 2011 study[8] shows that using data from 1996 to 2001 in the United Kingdom that the average survival rate (that is, surviving long enough to be discharged from hospital) of out-of-hospital cardiac arrests was 2.6%. The authors estimate that emergency response arriving a minute earlier increases survival from 2.6% to 3.2%.

If this data were to hold in a New Zealand context, given the approximately 2000[9] out-of-hospital cardiac arrests each year, an additional 12 lives may be saved if emergency responders arrived a minute sooner. It is unclear, however, if this study would apply to the New Zealand context as the survival rate, although down slightly from previous years, is already significantly higher (roughly 11%) compared to less than 3% in the United Kingdom where this study is from. Nevertheless, it is uncontroversial that faster emergency responders arrive on the scene, the better the outcomes are for those in need of emergency services.

[7] Payne, D. (2000). Poor Ambulance Response Causes 700 Deaths Annually in Ireland. British Medical Journal, 321(7270), 1176.

[8] O'Keefe, C., Nicholl, J., Turner, J., & Goodacre, S. (2011). Role of Ambulance Response Times in the Survival of Patients with Out-of-hospital Cardiac Arrest. Emergency Medicine Journal, 28, 703-706.

[9] https://www.stjohn.org.nz/news--info/our-performance/cardiac-arrest-annual-report/

"Simulation and analysis of traffic flow for traffic calming", (2017)

In this 2017 literature review, Abdi et al.[10] found inconsistent results on how much speed bumps reduced vehicles' speeds, increased traffic density, and affected travel time. Generally, previous research suggested that how much traffic is delayed depends on the distance between speed bumps. Therefore, the authors wanted to discover how much traffic density, travel time and vehicles' speeds were affected in relation to different distances between speed bumps.

The authors surveyed 11 vehicles on a street with speed bumps at various distance intervals and measured the vehicle speeds and how they varied with speed bumps at different intervals. This information was then fed into a traffic simulation model, which was then used to determine the optimal interval between speed bumps.

They found that *shorter distances between speed bumps increases travel time*. Additionally, the authors found traffic density increased as distance between speed bumps decreased. However, the model the authors used to reach their conclusions did not consider disappearing or rerouting traffic and the reaction to speed bumps was based on the original survey of 11 vehicles. That said, it seems reasonable that more speed bumps spaced closer together would slow traffic more than fewer speed bumps placed further apart.

The strength of this study is that it is based on real, though somewhat limited data. However, the goals of traffic calming are generally to slow traffic to survivable speeds and to reduce the overall amount of traffic on a road. This study examines the impact of traffic calming devices on slowing traffic but not on the impact on overall traffic reduction. Therefore, it is likely that this research presents an upper bound of the impact of traffic calming.

2.1.2 Secondary research

A significant amount the research uncovered on traffic calming devices relies on citing earlier studies and recommendations where it is unclear what the source is. This research can still be valuable, and this section summarises some of this secondary research.

"The evaluation of the effectiveness of traffic calming devices in reducing speeds on "local" urban roads in New Zealand", (2006)

This 2006 master's thesis[11] includes an extensive literature review on (mostly international) research discussing the effectiveness of different traffic calming measures. An aim of the project was to serve as a basis for a design guide for New Zealand decision-makers designing traffic calmed streets. A key point of this thesis is that the majority of devices that have been installed in New Zealand (as of 2006) were not necessarily installed in accordance with best practice. Further, many road controlling authorities install traffic calming devices without monitoring the resultant effects. This lack of recordkeeping plus a turnover in staff means that lessons are not learned. This is compounded by the fact that there is no central database on where and what traffic calming devices have been installed.

Most of the relevant (to FENZ) information is secondary references. The primary research is less about the effects of traffic calming in New Zealand, and more an audit of where traffic calming is installed and whether it is aligned with overseas research and guidelines.

[10] Abdi, A., Bigdeli Rad, H., & Azimi, E. (2017). Simulation and analysis of traffic flow for traffic calming. Proceedings of the Institution of Civil Engineers, 170 (1), 16-28. https://doi.org/10.1680/jmuen.16.00005

[11] Minnema, R. (2006). The Evaluation of the Effectiveness of Traffic Calming Devices in Reducing Speeds on "Local" Urban Roads in New Zealand. [Masters thesis, University of Canterbury].

This thesis discusses emergency response directly in the following ways, primarily around international guidelines on traffic calming and emergency response:

- Road cushions were mentioned multiple times as being an alternative traffic calming measure to speed bumps because they can help both cyclists and emergency vehicles avoid going over a bump.
- It is mentioned that "because of passenger discomfort, 100mm high humps are usually not suitable for bus routes or where emergency services may be expected to pass the humps on a regular basis", however no reference for this is provided.
- It is also mentioned that 75 mm speed bumps were developed to help create traffic calming measures whilst not slowing emergency services. This seems plausible, but no reference was provided.
- This thesis mentions that in Portland, Oregon, offset speed tables were developed to help solve the delay issues speed bumps were causing emergency vehicles, presumably the delay measured in the Atkins and Coleman (1997) report summarised above.
- Delays to emergency vehicles up to 9.2s per device may be incurred for a Seminole speed table (75mm high), but no reference was provided. This is likely from Atkins and Coleman (1997).
- For offset speed tables, delays to emergency vehicles up to 2.0s per device may be incurred and there is a minimal change in traffic volume. However, no reference was provided. The most likely source is a study that aimed to get delays down to no more than 2.0 s per device.

In summary, this is a good resource of what some common recommendations are for road controlling authorities when implementing traffic calming. However, most of the recommendations seem to be based on "common sense" and assumptions – which is necessary when not much work has been done to study the actual impacts.

This resource is also one of a few (see others below) that suggest that road cushions are preferable to speed bumps/humps. Some things that are currently unknown are whether road cushions offer similar safety improvements as speed humps, whether road cushions create less delay for emergency services than speed humps in real-world conditions (as they do in theory), and whether road cushions are overall net beneficial to speed humps.

Another recurring theme with this, and other references, is that the work of Atkins and Coleman (1997) seems to be one of the only studies that focusses on traffic calming and its impact on emergency services.

"Traffic calming in Québec: Speed Humps and Speed Cushions", (2013)

This study[12] is essentially a summary of three fact sheets released by the Ministry of Transportation in Quebec, Canada[13]. The first fact sheet suggested that after an area has been identified as needing traffic calming elements, designers need to consult with the public and affected users (including emergency services). This part of the process is to ensure the measures do not negatively affect neighbourhoods or make it harder for agencies to do their jobs.

The second two fact sheets made the following suggestions for traffic calming:

[12] Berthod, C., & Leclerc, C. (2013). Traffic calming in Québec: Speed Humps and Speed Cushions. Journal of Civil Engineering and Architecture, 7(4), 456-465.

[13] We were unable to find any follow-on studies that looked at the impacts of traffic calming in Québec on fatalities, injuries, or emergency response.

- Speed cushions should be used in areas where speed humps would cause issues for emergency services (as speed humps can increase response time by 10s per speed bump – though like almost every other study, this seems to rely on the research from Atkins and Coleman).
- The width of each speed cushion should be designed so that the wider axle of an emergency vehicle can pass through unaffected.
- If consecutive speed cushions/humps are placed on a stretch of road, it will decrease vehicles' speeds more.
- Because both measures pose restrictions in the physical environment, modifying visual fields and road widths should be considered as traffic calming instruments first.
- Speed cushions/humps should only be installed on streets with little through traffic that are not regular public transit, emergency vehicle or trucking routes with speed limits less than 50 km/h.

In summary, the traffic calming guidance provided by the Ministry of Transport in Québec, Canada, is that speed humps should not be used on primary response routes for emergency vehicles. Instead, either traffic calming measures that focus on modifying visual fields, narrowing the road or speed cushions should be considered. However, it should be noted that these recommendations are not based on robust post-hoc analyses, but rather on the Atkins and Coleman study summarised above and an assessment that the geometry of speed cushions allows for most emergency equipment to bypass the traffic calming devices.

The ministry also suggests emergency services, alongside other affected transport users, should be involved during design phases of traffic calming installations.

"Traffic Calming Benefits, Costs and Equity Impacts", (1999)

The purpose of the paper[14] from the Victoria (Canada) Transport Policy Institute is to provide a framework for evaluating traffic calming based on research. The article goes over what each traffic calming measure does and includes a list of the benefits and costs to implementing traffic calming.

Overall, there are five recommendations to reduce the negative impacts traffic calming devices may have on emergency services. Like the previous study, these are general principles and based on post-hoc analysis. That said, the recommendations are:

- Establish extra large no-parking zones adjacent to fire hydrants to help fire trucks manoeuvre.
- Limit the use of skinny streets to low – and medium-density residential neighbourhoods.
- Limit the use of skinny streets to streets which are part of an interconnected network of streets (i.e., connected on both sides to other public streets, no cul-de-sacs).
- Avoid skinny streets on primary emergency vehicle routes.
- Prohibiting parking within 50' of an intersection (to allow fire trucks to make the turn).

Essentially this work recognises that traffic calming, like all things, imposes costs and benefits. And because almost none of these costs or benefits have been adequately measured, it is essential that evidence-based discussions take place going forward to ensure good outcomes for society.

[14] Litman, T. (1999). Traffic Calming, Benefits, Costs and Equity Impacts. Victoria Transport Policy Institute. https://www.vtpi.org/calming.pdf

"Traffic Calming Programs & Emergency Response: A Competition of Two Public Goods", (2000)

This is a thesis[15] that aimed to determine whether it was better for overall fatality rates to promote traffic calming or leave the transport system as is. This work is largely a "what if" scenario where the performance of emergency response in Austin, Texas (USA) with and without traffic calming was assumed rather than observed. This work determined that if traffic calming measures caused delays to emergency response then it would cost lives – particularly for those experiencing out-of-hospital cardiac arrest. This is undoubtably true. However, we would caution that this study, like many of the others, uses the Atkins and Coleman (1997) work as the basis for their conclusions.

2.1.3 Research summary

There is precious little research done on the impact of traffic calming measures on emergency response, and what does exist is of varying quality. The state of the research on how traffic calming impacts emergency services can probably be summed up in just a few bullet points:

- For those who need emergency services, outcomes are better when emergency services arrive sooner. The odds of surviving an out-of-hospital cardiac arrest are low to start. They get worse the longer the response takes.
- A figure of 9 to 11 seconds is often cited as the delay caused to emergency vehicles by speed humps. This is based on the Atkins and Coleman study referenced above. It is a "test drive" scenario comparing speeds on empty roads with traffic calming to roads without. This seems to be one of the only pieces of primary research on traffic calming and emergency response prior to 2020. There were a couple other "test drive" studies that found similar results, but no studies that we could find that looked holistically at traffic calming and emergency response times in real-world scenarios.
- In 2020, London put in a host of traffic calming initiatives across the city. A study showed that when traffic calming is introduced, delays due to traffic calming increase but delays due to other reasons decrease. The authors of this study suggest that these delays cancel each other out. This does not mean that we can draw the same conclusion in Auckland, but it does indicate that "test drive" studies on delay caused by traffic calming only capture the cost side.
- It is essential that emergency services and roading authorities communicate and recognise the concerns of one another. The London example is at least initially indicative that low-traffic neighbourhoods implemented through traffic calming do not necessarily result in increased emergency response time.
- Various "best practice" guidance exists around the world. This guidance often suggests that options like speed cushions can provide much of the benefit of interventions like speed humps, but without the negative impact on emergency services. This could be true but has not been demonstrated empirically. This is an area where FENZ and AT could do world-first empirical research that could guide emergency service providers internationally.

2.2 Summary of FENZ submissions and concerns

As a primary provider of emergency response in New Zealand, FENZ is understandably concerned with any policy change that can potentially impact the ability to deliver emergency services. MRC analysed more than ten submissions and have summarised them into the bullet points below. This is a high-

[15] https://nacto.org/docs/usdg/traffic_calming_programs_and_emergency_response_bunte.pdf

level summary and individual submissions have more nuance. However, the following themes are present throughout:

- FENZ has a legislative objective to protect lives, property, and the environment.
  - FENZ provides several services, required by legislation, towards these goals.
- In Auckland there is a high level of need for FENZ services.
- The need for FENZ services has increased and is likely to continue increase due to an aging population and climate change related disasters.
- In Auckland, FENZ supports the overall goal of traffic calming – especially anything that decreases congestion and reduced *overall* deaths (that is, the lives saved by traffic calming should be greater than the lives lost from any potential resultant decrease in service quality).
  - FENZ is in favour of tolling and bus-only lanes. FENZ believes these interventions clear traffic but do not impact FENZ ability to respond quickly.
  - FENZ is not in favour of physical traffic calming measures along primary or protected access routes because this could increase response times. This includes any vertical deflection devices such as speed humps, raised crossings, or speed tables. It also includes measures that narrow traffic lanes.
  - FENZ is concerned about barriers that stop traffic flow (i.e., partial or full street closures) as these can impede access by FENZ appliances.
  - FENZ is concerned about the cumulative impacts of speed limit reductions, when combined with traffic calming interventions, on response times
  - FENZ is concerned about the impact of congestion on response times
  - FENZ is concerned about the cumulative effect of some of the planning rules like removal of minimum parking requirements and the effect it could have on site access, overflow parking on side streets, and any resulting impacts on response times
- FENZ want to be a key stakeholder in decision-making (on par with freight) and want decision-makers to consider the FENZ vehicle access guide when making changes to roading.

For an organisation that is legislatively tasked with protecting lives, property, and the environment, it is reasonable for there to be concern about how changes to infrastructure and policy will impact emergency response times and/or access. Unfortunately, the existing evidence on what these impacts might be is quite thin (as summarised in section 2.1) and provides little guidance on which of these changes is likely to have the largest impact of FENZ operations. Consequently, it is difficult to prioritise which interventions FENZ should be most concerned with and work the hardest with the roading authorities to address.

The qualitative analysis section of this report attempts to give some direction using first principles but is limited by the reality that precious little research has been done on this topic – despite near universal agreement about its importance.

This highlights the need for better data collection and analysis. It is concerning that traffic calming interventions have been used to various degrees for at least the last 30 years across the world and there is little ex post analysis of the impact to be found in the literature.

3 Quantitative Analysis

The quantitative analysis focusses primarily on traffic calming and traffic congestion on the effective response times of FENZ services. The results in this section should be treated as preliminary indicative results as the data available is not detailed enough to distinguish between different types of interventions and their impact on effective response times.

An ideal scenario would consist of two identical corridors, with identical traffic flows and service catchments, but different traffic calming interventions. As we exist in the real world, of course, there is no ideal data collecting scenario.

There are two difficulties with doing a comprehensive analysis that results in the ability to identify causal factors for changes in speeds. The first is that, historically, AT has not done proactive, area-wide safety interventions. This means that there are not too many instances of a wide area being given a safety treatment all at once, with an easy to distinguish "before" and "after" period (though one is used as a case study later in this section). Historically, things like speed humps or other vertical traffic calming devices have been installed piecemeal or on just one road at a time.

A second difficulty is that the world around the traffic network is constantly in flux. Traffic volumes are either decreasing or (usually) increasing, and other small but potentially impactful changes are being constantly made. Put another way, there is no way to identify "the roading network" because as soon as you have done so, it will have changed in some way.

That said, there are still statistical techniques – some quite robust – that can help us paint a picture of overall trends in the roading network and volumes that FENZ must deal with when providing emergency services. These statistical analyses rely on a few sets of data of varying quality.

3.1 Data availability and limitations

The data we received from FENZ was quite rich, if limited in a couple ways. Of note, the data included the following:

- date
- time
- responding station
- the station alert time
- enroute time
- arrival time
- the geolocation of the incident.

From this, we were able to calculate the response time (arrival time minus enroute time), the crow-fly distance from the station to the incident, time of day of response (morning peak, interpeak, evening peak, or night), and *effective speed*[16] (the crow-fly distance divided by time).

As we do not have information on the routing that the appliance used to get from the station to the incident, we cannot calculate the actual distance travelled or the actual speed – though the crow-fly distances allow us to proxy these. What cannot be adequately proxied, however, is the type (and number) of traffic calming interventions encountered or the likely congestion present on the route.

[16] Please note this term "effective speed" as it is used throughout the quantitative analysis section as a proxy for how quickly an appliance is able to respond to an event.

AT has publicly available[17] traffic count data. While this data is limited to an indicative snapshot of traffic flows at a point on the road, these snapshots are frequently taken at the same physical location. This allows changes in traffic volumes to be estimated through time, though these values are, by their very nature, not precise measurements. While we cannot know for certain that an appliance passed through a specific area with these traffic volumes, we can use an overall trend of the volumes in an area to indicate what changes were likely to have been confronted.

Additionally, AT has information available about where vertical traffic calming devices are located (though the version made available to MRC seemed to be somewhat out of date and, as of the time of report writing, another source was not found). While we do not know the precise routes taken by appliances, we can identify areas with a higher-than-normal occurrence of vertical traffic calming devices.

The Ministry of Transport collects high-level data on vehicle kilometres travelled (VKT) for each region and has a split by the type of road. This data helps give an overall picture of the traffic levels in the region but is not adequately disaggregated to help us determine where (and when) may pose an issue for FENZ responses.

Nonetheless, putting all these data sources together allows us to make some educated inferences, even when it does not give us outright bulletproof statistical proof of certain patterns that are happening across the Auckland region in terms of response times and speeds.

3.2 First impressions

The first step was to clean the data provided. To do this, we removed outliers in distance (for instance, one set of coordinates implied a response distance of nearly 500km), callouts with elapsed times less than 30 seconds or more than two hours, callouts with an implied effective speed of more than 1000 kph, callouts that originated at a rural fire brigade, and callouts that did not originate at a fire station. We also excluded the Auckland Operational Support Unit.

This results in 29 stations across the Auckland Region being included in the analysis which are within the urban area, which is where congestion and roading interventions are most likely to be an issue. Table 1 shows some summary statistics for the cleaned dataset.

Table 1 Summary statistics of callouts for all of Auckland in cleaned dataset

	10th percentile	25th percentile	50th percentile	75th percentile	90th percentile	Average
Distance (km)	0.63	1.08	1.79	2.64	3.71	2.11
Time (m:ss)	1:52	2:40	3:44	5:04	6:45	4:11
Callouts per day	32	36	42	47	54	42.8

From Table 1 we see that, from the cleaned dataset, across the entire 2016 – mid-2022 timeframe, an average Auckland day has around 42 callouts that originate from a station. 90% of days see 54 or fewer of these types of callouts and 10% of days see 32 or fewer. The average callout is 2.11 km from

[17] https://at.govt.nz/about-us/reports-publications/traffic-counts/

the station in straight-line distance and it takes and average of 4:11 for the first appliance to arrive. Half of all callouts are less than 1.79 km from the station and for half of all callouts, the elapsed time from leaving the station to arriving on the scene is less than 3:44.

Data across all of Auckland

Figure 1 shows a scatter plot of the effective callout speeds through time as well as a line graph of the average monthly effective callout speeds. The line graph also includes indications of extended (more than one week) times spent at Alert Levels 3 and 4 of the COVID-19 Alert System[18]. Time spent at Level 4 is indicated with red and time spent at level 3 is indicated by orange. This figure contains data from all the 29 Auckland stations included in our cleaned dataset. On the scatter plot, the red line is the best fit regression line through the more than 100,000 callouts on which we have complete data.

In terms of effective callout speeds – the variation is quite large. Some callouts have an average speed of near 60kph where others are near zero. As can be seen from the fitted lines, the average effective speed has dropped steadily from approximately 30.9 kph at the beginning of 2016 to about 28.7 kph in mid-2022. Given an average callout distance of 2.11 km, this means that from 2016 to mid-2022, an average distance callout takes an additional 18.8 seconds from the time the appliance leaves the station until it arrives at the scene. The line graph of monthly averages shows a similar pattern.

The second panel of Figure 1 shows that the pattern in monthly average effective speed *may* have changed across all Auckland in mid-2021. This may be related to covid lockdowns, with those time periods shaded in the figure. However, the direction of effect is the opposite of what we might expect during lockdown as some of the lowest observed effective speeds were seen during covid alert Levels 3 and 4, despite many fewer people travelling on the road. As this represents only a couple of data points, this is something that should be reinvestigated in future. While it appears that the pattern may have changed, it is just too soon to say for sure and the next few months of data could indicate that the pattern has not changed materially.

Another question we had which is difficult to visually answer from Figure 1 is whether effective callout speeds are becoming more variable through time. That is, we can see that, on average, speeds are slightly slower. But how has the spread in callout speeds changed through time?

An analysis of the variance of effective callout speeds indicates that the variability – which changes from month to month and year to year – has no particular pattern. In 2016, effective callout speeds were just as variable as they are in 2022. This indicates that while speeds have gotten slightly slower, the variability in speeds has not changed.

[18] https://covid19.govt.nz/about-our-covid-19-response/history-of-the-covid-19-alert-system/

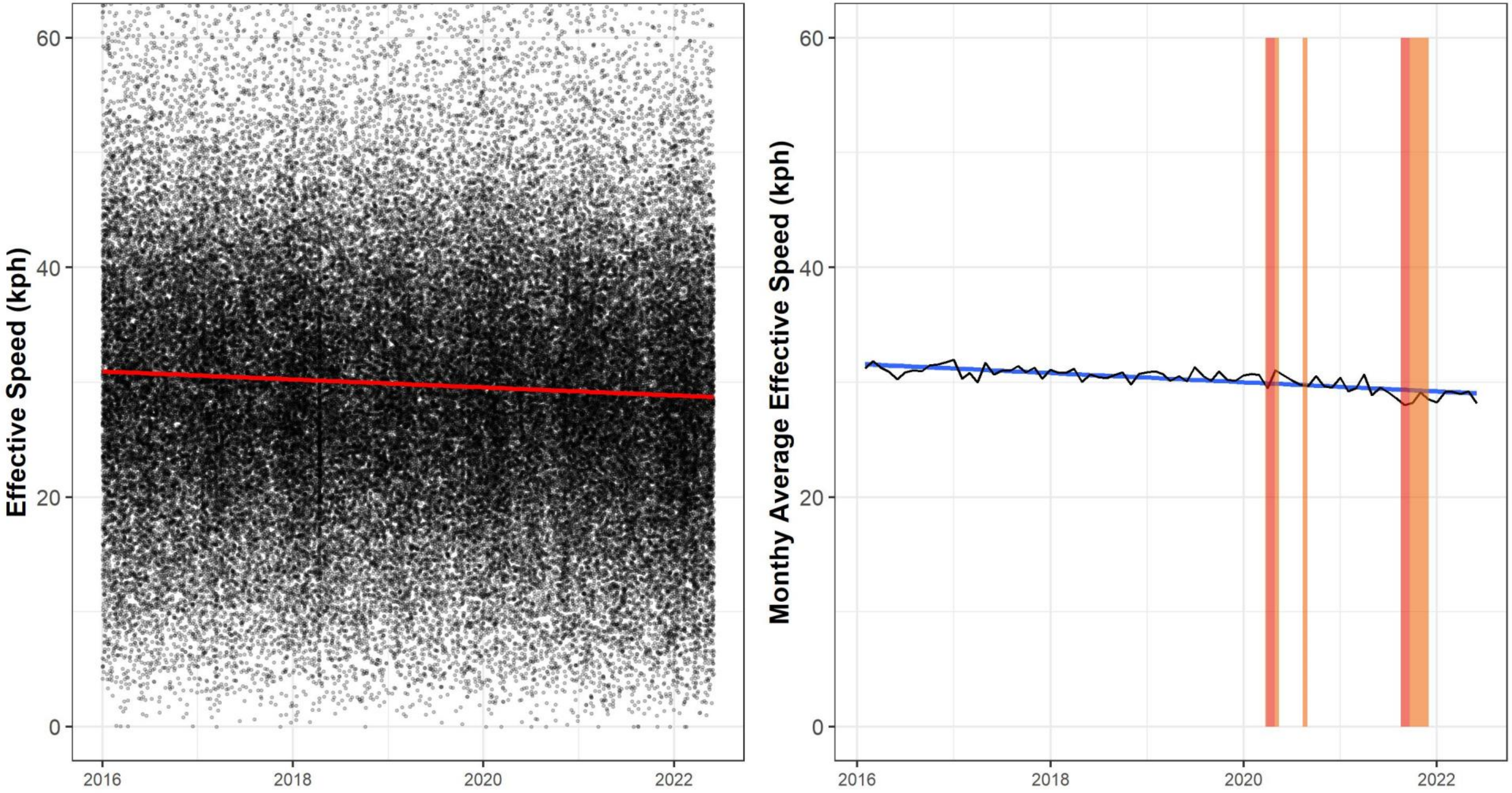

Figure 1 Effective speed of callouts across all Auckland Stations

3.2.1 Data by station

As mentioned at the beginning of Section 3, there are 29 stations in our cleaned dataset. Table 2 shows these stations, ranked by the total number of callouts (as defined previously). The busiest station in the dataset is Auckland City with over 60% more callouts than the next busiest station and the least busy is Titirangi with about 9% as many callouts that originate from the station as Auckland City.

Table 2 Stations in the dataset, ranked by number of callouts

Rank	Station Name	Total callouts	Rank	Station Name	Total callouts	Rank	Station Name	Total callouts
1	Auckland City	10,838	11	Silverdale	3,443	21	Balmoral	2,486
2	Papatoetoe	6,646	12	Mt Wellington	3,431	22	E Coast Bays	2,450
3	Mangere	5,109	13	Parnell	2,945	23	Mt Roskill	2,387
4	Manurewa	4,948	14	Grey Lynn	2,935	24	W Harbour	2,306
5	Otara	4,866	15	Ellerslie	2,804	25	Te Atatu	2,274
6	Papakura	4,446	16	Howick	2,743	26	St Heliers	2,200
7	Takapuna	4,242	17	Albany	2,726	27	Birkenhead	2,046
8	Henderson	4,123	18	Remuera	2,675	28	Devonport	1,230
9	Otahuhu	3,940	19	Onehunga	2,619	29	Titirangi	983
10	Avondale	3,792	20	Glen Eden	2,579		Total	100,212

A scatter plot of the effective callout speeds through time, by station is shown in Figure 2. The density of the plots shows the relative busy-ness of each station (i.e., the plot will appear darker if there are more callouts), and the red lines are the best fit regression line through the callout speed data.

A few patterns become obvious. The closure of the Balmoral Station for renovations is clear with a complete absence of callouts for several months leading into 2020.

Just like with the Auckland-wide data, the variation in callout times at each station is quite large. Some callouts have an average speed of near 60kph where others are near zero. This is true for all stations in the sample, though the more urban stations tend to have fewer high-speed callouts, as would be expected. The long-term trend at all stations (shown by the red lines) is either that effective speeds are slowing or flat. For 14 of the 29 stations, speeds are not statistically different through the time period of our sample, where for remaining 15, speeds are statistically slower. Stations with a statistically significant change in speed have been annotated with an asterisk in the figure.

Grey Lynn Station has seen the largest decrease in effective speed since 2016; closely followed by East Coast Bays Station and Birkenhead Station. In contrast, West Harbour Station was the only station with an increase in effective speeds, though it is statistically insignificant.

Figure 3 illustrates the same data as monthly averages, with the best fit regression line (weighted by observations in each month) fit through the monthly data. The patterns are roughly the same, though as expected, there is much less variation in the graphs as we do not get to see each individual callout. Incidentally, this is why the stations which have statistically significant changes in speed has slightly changed. The monthly aggregation "hides" some of the variation. While the line graph is easier to read and potentially more instructive, it contains less information than scatter plot with each callout.

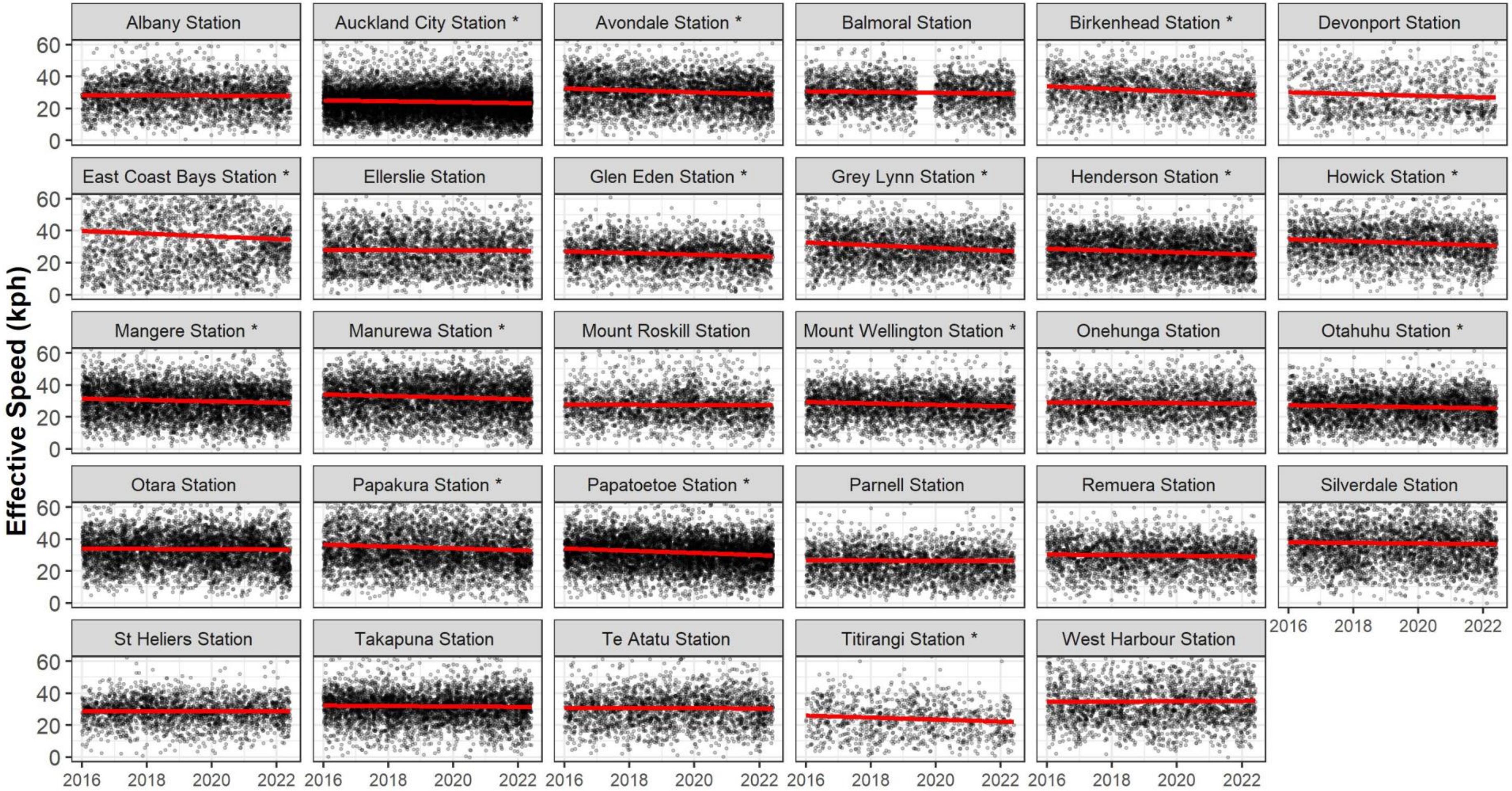

Figure 2 Effective speed of callouts, by station of origin

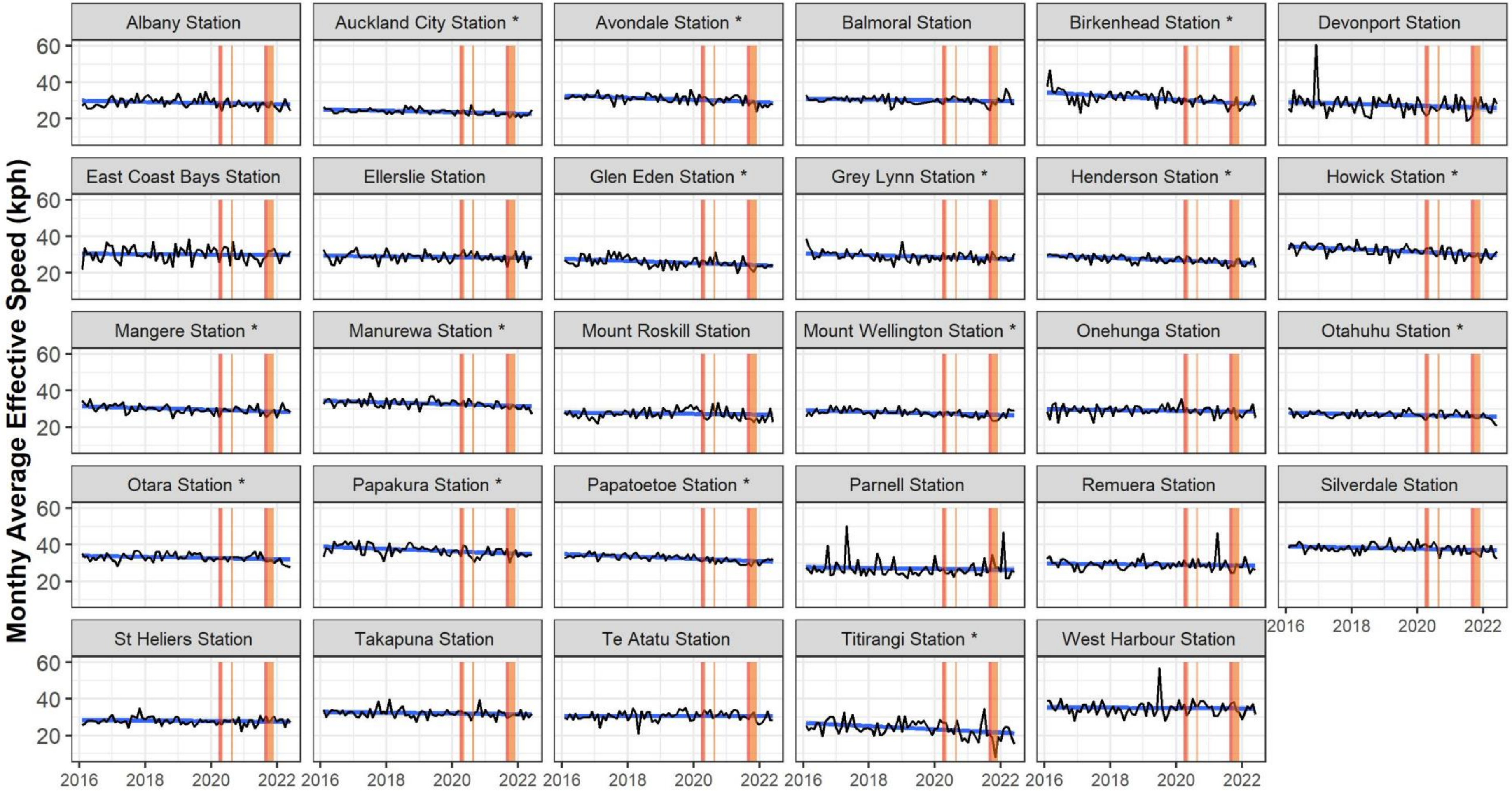

Figure 3 Monthly average effective speed of callouts, by station of origin

By both measures, there are 14 stations that show statistically significantly slower effective callout speeds as shown in Table 3 and Figure 4. Of note, 8 of the 10 busiest stations have seen statistically significant slower effective callout speeds since 2016. For the station ranked in the middle in terms of busy-ness, 4 of 10 have slower effective callout speeds, while only 2 of the 9 least busy stations do. Whether a station has seen decreasing effective callout speeds does not seem to be highly determined by geography – though the North Shore area of the city only has one station with decreasing speeds.

Table 3 Stations, ranked by callouts, with (statistically significant) slower effective callout speeds

Rank	Station Name	Slower callout speeds	Rank	Station Name	Slower callout speeds	Rank	Station Name	Slower callout speeds
1	Auckland City	Yes	11	Silverdale		21	Balmoral	
2	Papatoetoe	Yes	12	Mt Wellington	Yes	22	E Coast Bays	
3	Mangere	Yes	13	Parnell		23	Mt Roskill	
4	Manurewa	Yes	14	Grey Lynn	Yes	24	W Harbour	
5	Otara		15	Ellerslie		25	Te Atatu	
6	Papakura	Yes	16	Howick	Yes	26	St Heliers	
7	Takapuna		17	Albany		27	Birkenhead	Yes
8	Henderson	Yes	18	Remuera		28	Devonport	
9	Otahuhu	Yes	19	Onehunga		29	Titirangi	Yes
10	Avondale	Yes	20	Glen Eden	Yes			

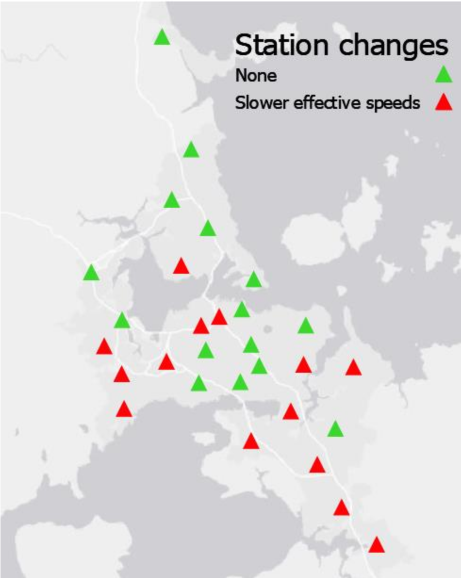

Figure 4 Map of stations with statistically significantly slower effective callout speeds

The patterns shown in Figure 4 and Table 3 suggest that the busiest stations are also the ones where concern around response times and speeds is most warranted, but there is not one area of the city that is of more concern than others.

3.2.2 Traffic and congestion

As stated in the introduction, Auckland has been growing at a rate well about the national and world average for quite some time. All those additional people have historically meant more cars on the road and more VKT. Figure 5 shows the trend in VKT for the Auckland region, as estimated by the Ministry of Transport. While the trend isn't smooth – and the estimation techniques not perfect – what we see is an upward trend in the VKT on local roads and a general upward trend in overall VKT. There is a dip in the 2020/2021 period in which there were covid restrictions on travel, though this only seems to have affected state highway travel, not travel on local roads.

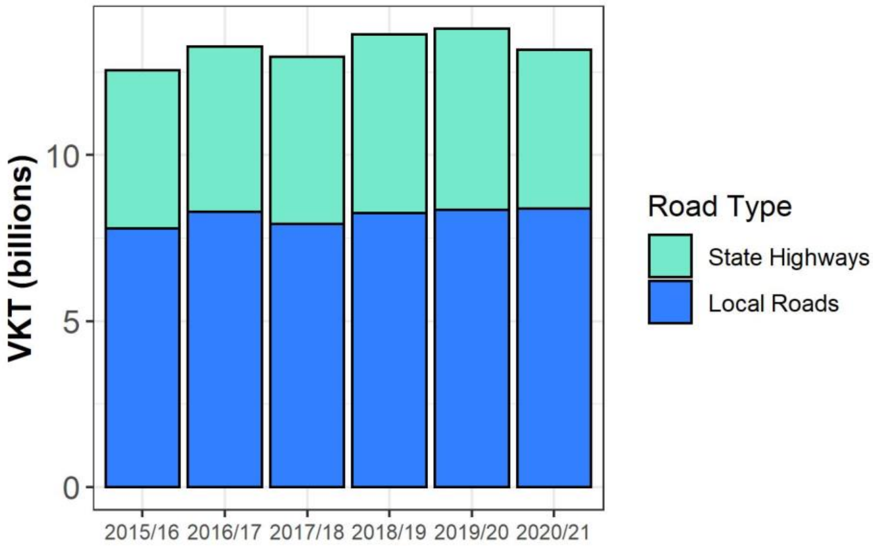

Figure 5 Auckland VKT, by year, by road type

The implication of these patterns is that traffic and congestion is likely to be the same or (likely) worse through time. While there were some periods during 2020 and 2021 where congestion was significantly less bad than normal during i.e., Covid alert Levels 3 and 4, for the most part, traffic has been increasing. Even during covid-free periods of 2020 where the country was at covid alert Level 1, congestion into the city centre was essentially at pre-pandemic levels[19].

3.2.3 Development and response speed

Figure 6 shows a map of dwellings consented between 2016 and 2021 by Statistical Area Level 2 (SA2)[20] and the location of fire stations in Auckland. The hypothesis is that fire stations in areas that are rapidly growing might see a decrease in effective callout speed and stations in areas with little growth will have consistent speeds.

The map does not appear to show a definitive pattern. While most stations that have seen reductions in speed are adjacent to areas experiencing rapid growth, this is not universally true. Titirangi Station has seen decreases in speed but not much growth. On the other side, West Harbour Station is adjacent to the fastest growing area in the city and has experienced no change in effective callout speeds.

[19] https://www.aucklandcouncil.govt.nz/about-auckland-council/business-in-auckland/docsoccasionalpapers/auckland-economic-quarterly-november-2020.pdf

[20] SA2 geography aims to reflect communities that interact together socially and economically. In populated areas, SA2s generally contain similar sized populations. SA2s are defined by Stats NZ. https://datafinder.stats.govt.nz/layer/106728-statistical-area-2-2022-generalised

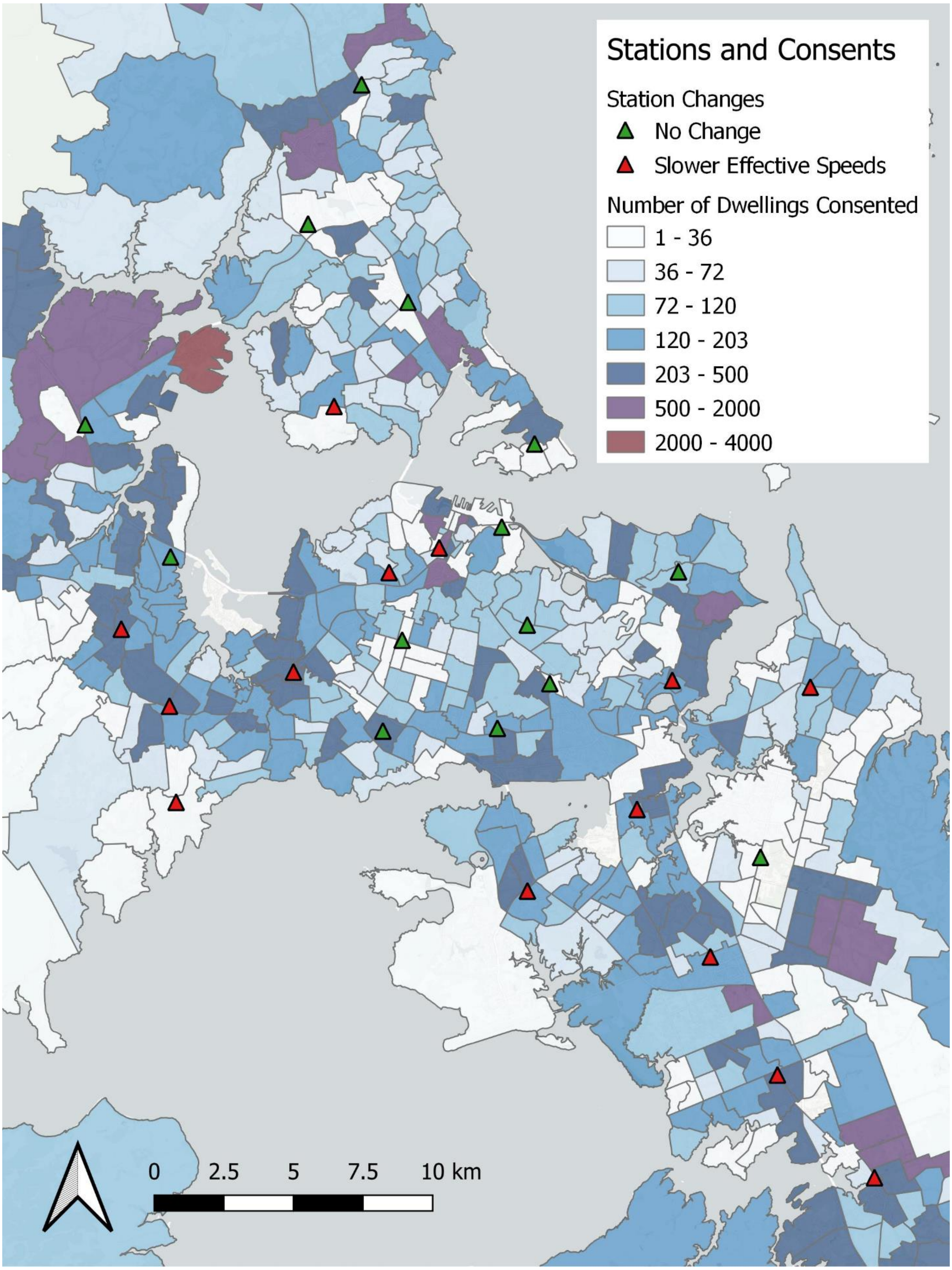

Figure 6 Dwellings consented 2016-2021 and fire station location

An area for future research could be investigation into why some stations adjacent to rapid growth (Te Atatu, West Harbour, Onehunga, Ellerslie) have not seen their effective callout speeds slow, where other stations in rapidly developing areas (Mount Wellington, Papatoetoe, Henderson, Papakura) have seen their effective speeds fall.

3.2.4 Summary of Auckland-wide data

This quantitative analysis shows that, in aggregate, Auckland-wide effective callout response speeds to be slowing through time. This seems to be happening at a constant rate. There may be a systemic change that happened in mid-2021 but it is too soon to tell for sure as the speed data generally bounces around from month to month. Across all of Auckland, the amount of traffic on local roads has been flat or increasing over time, even with the pandemic.

Drilling down into individual stations, roughly half of stations have seen a decrease in effective response speeds while the other half have stayed constant. No stations in the dataset have seen an increase in effective response speeds and covid lockdowns do not seem to have had a meaningful impact on speeds despite significantly less traffic on the roads.

Of the 10 busiest stations, 8 saw a statistically significant reduction in effective callout speed between 2016 and mid-2022, while only 2 of the 9 least busy stations did. This seems to indicate that reductions in speed are predominantly affecting the busiest stations. However, there does not seem to be much geographic pattern to this data as stations with slower speeds and stations that have been unaffected are spread across the region.

Additionally, there is a mix of fire station effective callout speeds in relation to areas of rapid development. There are areas of the city seeing rapid growth and the adjacent fire stations are experiencing a measurable reduction in effective callout speeds. Yet, there are other areas of the city with equally rapid growth and seemingly no impact on the adjacent fire stations' effective callout speeds.

3.3 Case study

Ideally, to determine how traffic calming, congestion, and everything else impacts effective callout speeds, there would be a controlled environment where everything could be held constant, and one thing tested at a time. However, that is not practical within this scope. Instead, a natural experiment approach where one part of the city gets a treatment (in this case vertical traffic calming) and other areas do not has been used. For this report, we selected Manurewa for this.

3.3.1 Manurewa case study

FENZ has concerns that the Manurewa road safety improvements may have impacted effective and efficient emergency response as the same interventions designed to improve road safety may have the potential to slow emergency response.

The first phase[21] of the safety improvements in Manurewa involved the installation of 11 raised table zebra crossings, 10 raised Swedish style speed tables, and 117 speed humps. The Manurewa Fire Station is located approximately 600 metres east of the first phase of the safety improvements. A map of the area is shown in Figure 7. The dark shaded area is where the traffic calming interventions have been placed. The lighter shaded area is the parts of Manurewa that cannot be reasonably accessed without passing through the area with the interventions. The green marker shows the location of Manurewa Station. All available information points to this project having been started in mid-2020 and fully completed by January 2021.

[21] https://at.govt.nz/projects-roadworks/vision-zero-for-the-greater-good/safe-speeds-programme/residential-speed-management-programme/manurewa-road-safety-improvements/

Figure 7 Map of Manurewa area and fire station location

Statistical analysis of aggregate data for Manurewa

To examine whether these 100+ speed interventions have had meaningful impacts on response times, we have sorted the data a few different ways. First, we looked at the overall pattern of effective callout speeds as shown in Figure 8. For the most part, two fire stations handle the callouts to the area impacted by the safety improvements – Manurewa Station and Papatoetoe Station – with Manurewa Station handling the vast bulk (around 90%) of the responses.

Figure 8 shows that callouts to the affected part of Manurewa have been experiencing decreasing effective callout speeds since 2016, regardless of whether the appliance was coming from Manurewa Station or Papatoetoe Station. As before, the shaded areas on the line graph show where Auckland was under level 3 or level 4 covid alert settings.

Visually, there does not appear to be a sudden deviation from the overall time trend in effective callout speeds – something that is confirmed using a statistical technique called a Chow Test. This type of test looks for a "breakpoint" in a data series, essentially asking the question "does a time series trend have a different slope (and intercept) before a certain point in time than it does after a certain point in time?" Chow test results for Manurewa station before mid-2020 and after January 2021 show that the best fit line through the data is not significantly different in either period.

The conclusion is that basic statistical techniques were unable to detect a significant difference between the effective callout speed before and after the interventions, beyond what would have been expected regardless. That is, speeds have been decreasing through time, and the past year and a half of data is not out of line, statistically speaking, from the pattern beforehand.

This *does not* rule out that the interventions in Manurewa have slowed response times, but merely says that at this point there is not concrete statistical evidence that response times have slowed over and above what should have been expected with business as usual.

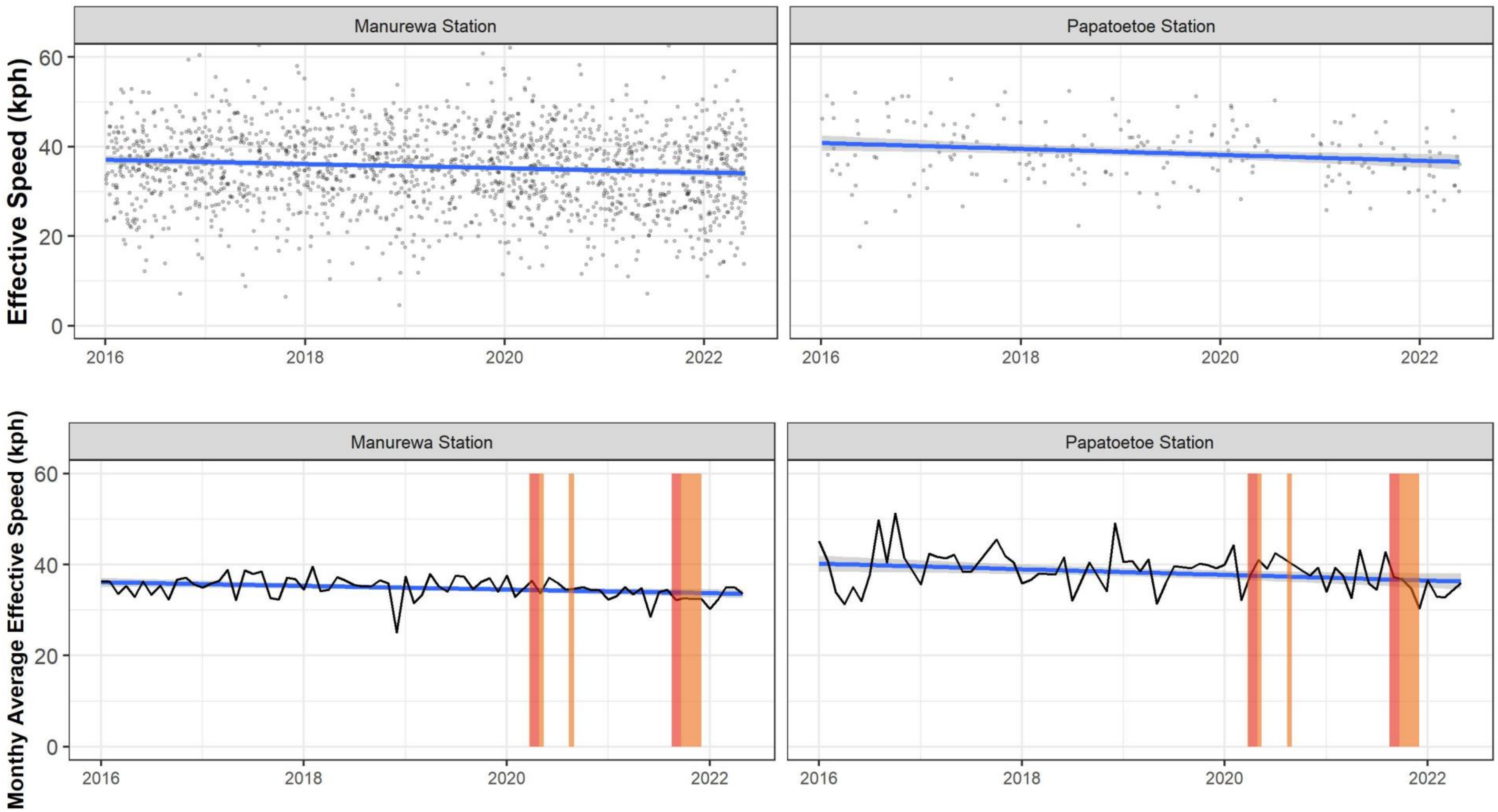

Figure 8 Effective speed of callouts to impacted area in Manurewa

Traffic patterns around the affected area in Manurewa

While we cannot rule out that the interventions have slowed effective response speeds in Manurewa, perhaps there are some other explanations for why speeds have slowed through time? We obtained traffic count data from AT which could give us some additional information.

Traffic count data is not perfect. The pneumatic tubes used to count vehicles are placed out for a couple days at a time, once a year in most locations. They give a good indication of traffic volumes and patterns, but more frequent counts would be needed to draw definitive conclusions. Figure 9 shows the traffic counts through time at seven locations in Manurewa where the traffic calming interventions have taken place. The title of each chart shows the road on which the measurements were taken place (top name) and the nearest cross street (bottom name).

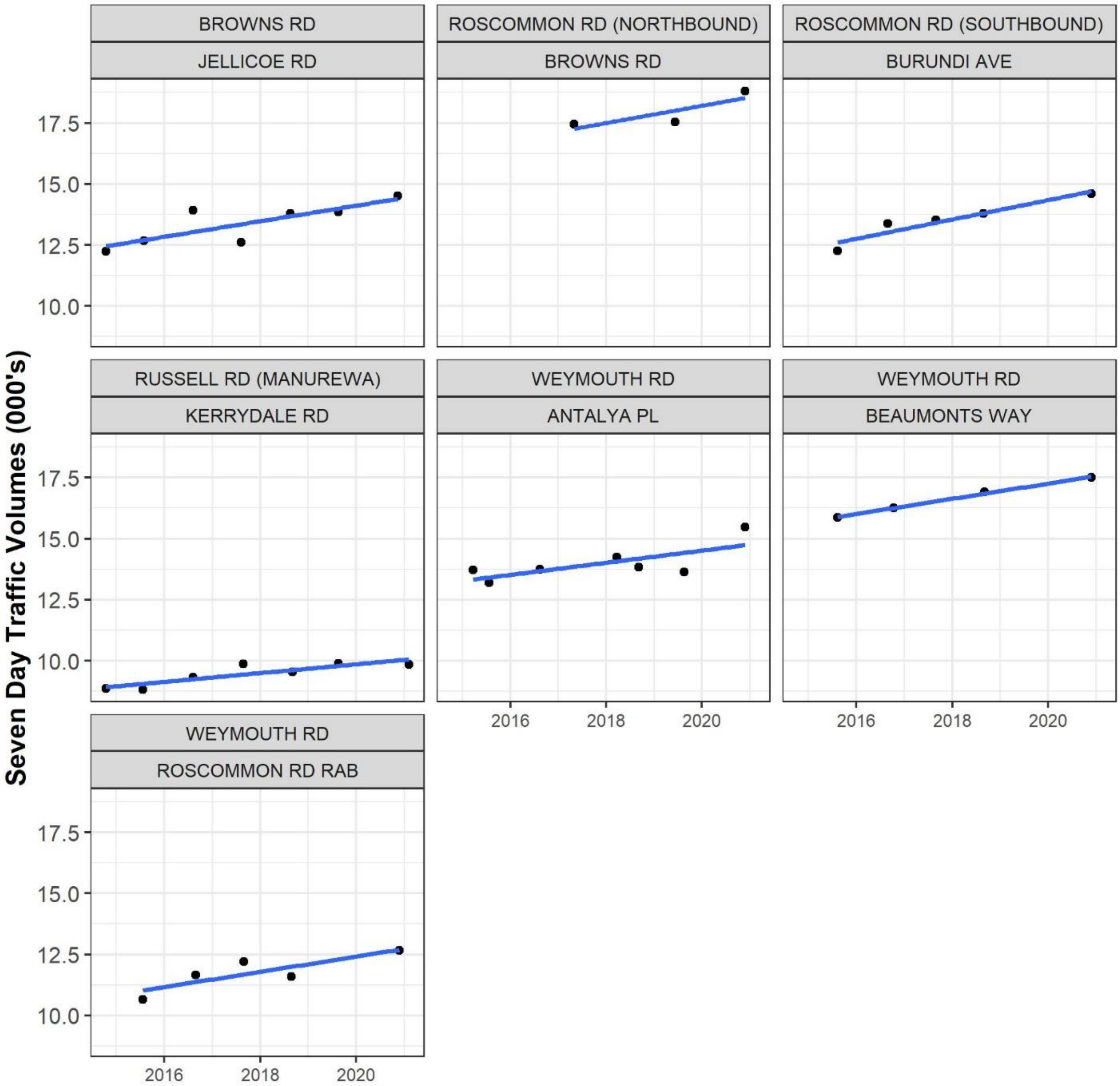

Figure 9 Traffic counts around the Manurewa area of interest

In each case, traffic volumes seem to be increasing significantly through time. It is likely that this plays a role in the decreasing effective response speeds to this area. Also, none of the traffic volume measurements seem to have taken place since the traffic calming devices were installed. In all, the main issue is that there is not enough data, nor enough elapsed time to determine whether increased traffic volumes or increased use of traffic calming devices is impacting effective callout speeds more – though initial evidence suggests it is likely not primarily from the traffic calming devices. Similarly, not enough time has elapsed for the traffic volume impacts of the traffic calming devices to be analysed.

Manurewa by time of day

Another way to investigate what could be impacting effective callout speed is to look at data on when during the day the callouts happen. The rationale is that during peak hours, both traffic volumes and traffic calming devices could be impacting speeds. But at night (say, from 9pm to 5am), if there was an impact on speed, it would likely be from traffic calming devices as they are present 24 hours a day, whereas congestion is not.

To examine this, we have broken the day into six periods – Early Morning (5am to 7am), Morning Peak (7am to 10am), Intra-peak (10am to 3pm), Evening Peak (3pm to 6pm), Night (6pm to 10pm), and Late (10pm to 5am). We have graphed the average monthly response time by period as shown in Figure 10 and fit a regression line. We have not included callouts from Papatoetoe Station as there was not enough data to slice into periods of the day.

The data reveals that effective callout speeds have gotten statistically significantly slower during the morning, morning peak, and night periods. While it appears that speeds have gone up in the evening peak, the change is not statistically significant. In the intra-peak and late periods, the slope is statistically zero. That is, the effective callout speed in 2022 is identical during the intra-peak, evening peak, and late periods.

Of most interest is that speeds during the late period (10pm to 5am) effective speeds are unchanged. This seems to indicate that the vertical speed calming devices do not cause detectable delay – at least when there are no other vehicles on the road.

Manurewa case study summary

There is no doubt that effective callout speeds have slowed over time in Manurewa. However, there is not enough evidence to show that the vertical speed calming devices installed as part of the first phase of safety improvements there caused the callout speeds to be slower than would be expected given the trend on callout speeds in general. We also note that the design in Manurewa was somewhat modified by AT in response to FENZ concerns. At the very least, this demonstrates that collaboration between AT and FENZ on such interventions should be encouraged.

Additionally, we have not ruled out that congestion plus the traffic calming devices cause more delay than congestion alone, as there is not much evidence one way or another. This is an area to keep an eye on going forward and an area for future research.

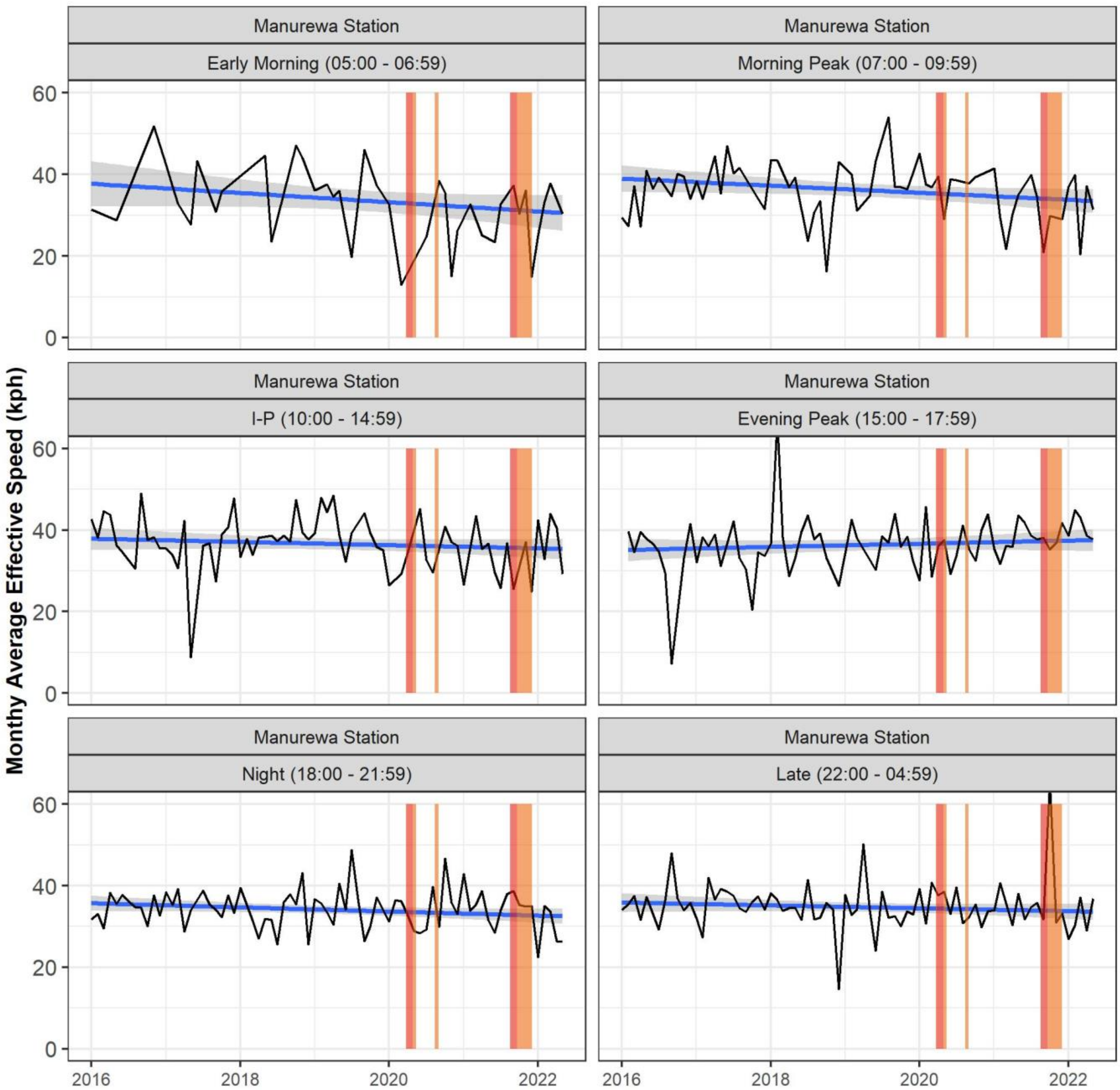

Figure 10 Effective speed of callouts to impacted area in Manurewa, by time of day

4 Qualitative Analysis

Given the inconclusive nature of the existing literature and the quantitative analysis of Auckland and, specifically Manurewa, we have undertaken a qualitative assessment of likely impacts of traffic calming interventions, the removal of parking minimum requirements, changes to transport strategies, and the lowering of speed limits. Each of these has the potential to impact on FENZ's in various ways – both positive and negative.

This section covers:

- Traffic calming – the tensions between emergency responses and traffic calming devices; the lack of robust evidence; consideration of different traffic calming devices on emergency services; the benefits of traffic calming on response times; the potential impacts of traffic calming on staff and appliances.
- Traffic congestion – consideration of the impacts on emergency services
- Implications of the removal of minimum parking requirements
- Benefits of a compact city on response times
- Reducing speed limits
- Working with AT.

4.1 Traffic calming

While FENZ strongly supports the general principles of reducing deaths and serious injuries on our roads, it has concerns with the types of traffic calming street design measures that are increasingly being implemented to deliver these safety outcomes. In particular, there is concern that the interventions put in place to reduce road deaths and injuries could increase deaths and injuries from delayed emergency response.

4.1.1 Tension between street design and emergency response

There is a definite tension between the street features that allow emergency services to travel at higher speeds and the features that ensure safety and amenity for road users and residents. For example, some of the street features that would allow emergency services to travel at higher speeds are:

- Wide streets that allow unobstructed clear width with enough room to pass other vehicles (moving and parked)
- Wide traffic lanes
- Multiple lanes
- Parking prohibitions
- Large curb radii
- Lack of constraints along the route (traffic signals, stop signs, traffic circles, curb extensions, speed humps, chicanes, other traffic calming measures)
- Lack of features that limit the ability of firefighters to cross the centreline of the street (medians, pedestrian islands, etc.).

However, in some cases these features are in opposition to the types of traffic calming features increasingly being implemented in New Zealand both through the Waka Kotahi's Standard Safety Intervention Toolkit and AT's standard traffic calming toolkit. These measures include:

- Narrower traffic lanes - extending the footpath, adding bollards or planters, or adding a bike lane or parking.
- Kerb extensions - narrow the width of the roadway at pedestrian crossings.
- Chokers - curb extensions that narrow the roadway to a single lane at points.
- Chicanes - create a horizontal deflection causing vehicles to slow as they would for a curve.

- Allow parking on one or both sides of a street.
- Speed humps or cushions. The latter being a series of three small speed humps that slow cars down but allow emergency vehicles to straddle them so as not to slow response time.
- Speed tables - long flat-topped speed humps that slow cars more gradually than humps.
- Raised pedestrian crossings and raised intersection.
- Pedestrian refuges or small islands in the middle of the street.
- Median diverters - prevent left turns or through movements into a residential area.
- Changing the surface material or texture (for example, the selective use of brick or cobblestone).
- More give way signs.
- Converting an intersection into a cul-de-sac or dead end.
- Boom barriers - restricts through traffic to authorised vehicles only.
- Closing of streets to create pedestrian zones.

This tension is not unique to Auckland or New Zealand, it is present internationally, wherever traffic calming has been implemented. As noted in the National Association of City Transportation Officials (NACTO) Best Practices Emergency Access in Healthy Streets guidance:

> *"Measures that allow for large fire vehicles to travel at high speeds generally allow and encourage high-speed driving by all vehicles, and the result can be a significant decrease in safety for all users of the streets. Similarly, designs which make it easy for fire vehicles to cross the centerline of streets, such as eliminating raised medians, make it possible for all vehicles to cross the centerline easily, which can result in increases in head-on collisions and other types of collisions. In short, street designs that enable high-speed driving and maneuvering can improve emergency response times, but frequently worsen traffic safety".*[22]

4.1.2 Lack of robust evidence on the impact of traffic calming on response times

There is general consensus in the guidance and literature that traffic calming schemes can affect emergency response times as outlined in Section 2.

Unfortunately, the guidance is of limited help for the following reasons:

- There is inconsistency in the guidance on the impact that specific traffic calming treatments has on emergency services response time. For example, some guidance shows that roundabouts are worse than vertical devices like speed humps or tables, other guidance says the opposite, and some concludes that there is little difference between devices [4,23] . This is likely down to:
    - the design of the specific devices used, e.g., an aggressive speed hump will slow traffic more than a gentle one; the geometric design of the roundabout has a huge influence on the speed at which it can be negotiated
    - the location of the devices on the emergency route
    - the spacing of devices and the road's operational speeds
- Some of the guidance says certain devices will have a greater impact on emergency services than others. However, it is not clear if this relates to response time or also include factors like wear and tear and discomfort.

[22] https://nacto.org/wp-content/uploads/2015/04/Best-Practices-Emergency-Access-in-Healthy-Streets.pdf

[23] Table 7.3: https://safety.fhwa.dot.gov/saferjourney1/library/pdf/toolsintro.pdf

- Where specific delays are included in the literature, the conclusions appear to be based on either observed or modelled traffic speeds in free-flowing conditions. These delays are then extrapolated and applied to potential schemes with the guidance concluding each type of traffic calming treatment would result in a specified delay to emergency services (sometimes this is given as a range, sometimes a specific number). This is problematic in several ways:
    - Free flowing conditions are not typical of how the urban network operates
    - It assumes that the position of each device on the network results in equal delay (e.g., raised tables at intersections have a similar effect as when they are mid-block)
    - It does not consider the type of appliance or driver skill
- There is little analysis on factoring in potential benefits to emergency response times that may be obtained through some of the other effects of traffic calming treatments. For example, traffic calming may reduce traffic local volumes, which may reduce congestion, which might in turn improve overall response times.
- It does not factor that the existing speed conditions may not be safe for emergency vehicles and other road users.

There is a lack of clear and consistent evidence on the real-life impacts of different traffic calming devices on emergency response times. This means it is difficult to make evidence-based arguments for particular traffic calming devices over other types of traffic calming devices.

4.1.3 A note on other factors that can influence response times

The factors that can determine response times are many and complex and beyond the scope of this piece of work. We have instead focused the discussion on the specific areas where FENZ has raised issues in their submissions in relation to the transport network.

The absence of definitive research and conclusive data on the relationship between some of the issues that FENZ has previously raised can be attributed to the difficulty in isolating specific factors and assessing their impact on response times. For example, all the following factors (and additional ones captured below) could have an impact on response times:

- Appliance type
- Driver skill and experience
- Location and number of fire stations
- Number of callouts
- Type of callout
- Road works and specific street conditions at time of callout
- Weather
- Local area knowledge of responders.

We note this to reinforce the complex nature of the relationship between response times and roading interventions.

We suggest there is a need to work with road controlling authorities from a first principles perspective to build knowledge as it becomes available through evaluating interventions, possibly through well-monitored trials.

4.2 Consideration of types of traffic calming devices for emergency services

In this section we provide a summary of the key visual, vertical and horizontal deflection devices most commonly used for traffic calming and considerations for emergency services. These are summarised in Table 4. Given the focus on the Auckland region this table has focused solely on the AT Transport Design Manual (TDM) and associated standards[24]. After the table some specific recommendations are outlined for how FENZ could increase its collaboration with AT in this space.

[24] https://at.govt.nz/about-us/manuals-guidelines/transport-design-manual/

Table 4 Summary of key visual, vertical, and horizontal traffic calming interventions

Type of deflection	Traffic calming device and description (Based on AT TDM[24])	Considerations for emergency services
Visual	**The use of paint and markings to reduce lane widths –** this can increase visual complexity for drivers and their perception of travelling speed, which can encourage speed reduction. Unfortunately, such designs generally don't physically enforce lower speeds, so have more limited effectiveness.	• There is a lack of robust evidence in the literature regarding the impacts of visual deflection on emergency services. Further investigations are required. • Paint and markings can be driven over by appliances. • Anecdotally, its understood that over time as drivers become accustomed to visual changes, the effectiveness of such measures at reducing speeds may reduce. • Any changes to lane positions may make it either easier of harder for emergency vehicles to bypass congestion, depending on their design.
Vertical	**Speed humps** - They are typically either formed from asphalt. Otherwise, lower cost and shorter-term projects often employ bolted-on rubber speed humps.	• There is a lack of robust evidence in the literature, as outlined in this report, regarding the impacts of speed humps on emergency services. Further investigations are required. • Possible impacts highly dependent on the materials used, where they are located, and spacing as outlined in Section 4.1.2 and Atkins and Coleman's work. • Often chosen as they are a low-cost traffic calming solution. • Speed cushions are a similar traffic calming device to speed humps which may be an alternative option in some cases. They are designed to reduce impacts on larger vehicles such as emergency vehicles.
Vertical	**Speed cushions** - consist of a narrow speed hump which only occupies the centre of the lane, designed such that larger vehicles can straddle the island and maintain greater speed. Most (smaller) vehicles have narrower axles which cannot effectively achieve this, and will have to	• As stated to the left from the AT TDM speed cushions are one of the traffic calming devices that specifically mitigates the impact of the vertical deflection on larger vehicles

Type of deflection	Traffic calming device and description (Based on AT TDM[24])	Considerations for emergency services
	mount the cushion, reducing speeds primarily of just those smaller vehicles. AT standards do not offer flexibility in the grade, size nor height of speed cushions.	• Effectiveness can be dependent on the road layout and provision of on-street parking i.e., parking might push the appliance further out into the street and the wheels will therefore not be able to straddle the cushions. This was one of the points noted in the conference paper[25] which covered the same Portland trials as outlined in the literature review (Coleman and Atkins, 1997). Consequently, the layout needs to be considered carefully.
Vertical	**Raised Tables** • <u>For pedestrian crossings</u> - Increasingly placing zebra crossings on a raised table is favoured. This is to ensure that conflict between pedestrians and other vehicles is at a 'survivable speed', defined as 30km/h, while also providing a more flush pedestrian user experience, and helping convey to road users that the 'road is crossing the footpath' rather than vice versa. For pedestrian crossings, other traffic calming solutions are increasingly considered inferior in terms of pedestrian usability and safety to a raised table. • <u>At intersection</u> - Raised tables are increasingly favoured at the entry point to local streets from collector and arterial roads, to signal to drivers that they are entering a street with a lower street classification and to create a safer, smoother and greater priority crossing point for pedestrians continuing straight through. Although raised tables are generally associated with a pedestrian crossing point, they do not always feature a zebra crossing to formalise pedestrian priority.	• Limited robust evidence in the literature regarding the impacts of raised tables on emergency services. The NACTO report on Best Practice Emergency Access notes that they are "*are preferred over speed humps since they impede emergency equipment and access less than speed humps while providing significant calming benefits*" [22] • Consideration could be given in Auckland to a similar approach to that applied to raised tables on frequent bus routes. These are specified to be designed to a modified Swedish ramp standard (AT standard TC0022), to reduce impacts on those prioritised vehicles. This design features a 75mm high table, along with a 1m long up-ramp, and a 3m long down-ramp.

[25] https://nacto.org/wp-content/uploads/2015/04/Offset-Speed-Tables_Batson.pdf

Type of deflection	**Traffic calming device and description (Based on AT TDM[24])**	**Considerations for emergency services**
	ATs standards include various raised table ramp designs: • A standard design of a 100mm high, 1:10 ramp • 'Swedish' raised tables which feature a down-ramp that is longer and less steep than the up-ramp to reduce the impact on vehicles without creating an unsafe conflict speed. These are only applicable to streets which have space for a centre island, given that up and down ramps are of different lengths and need to interface with each other.	
Horizontal	**Entry treatments -** Entry treatments to streets generally employ changes in texture, material, or markings, and generally used to demarcate the change from a main road (Collector or Arterial) to a side street (local road). These provide physical and audible feedback to drivers which encourages them to slow down. Similar to visual deflection (above), because they done enforce a maximum comfortable speed, they are unlikely to consistently reduce vehicle speeds to what is considered a safe conflict speed with pedestrians.	• As these treatments do not physically enforce slower speeds, they do not affect the speed of emergency vehicles
Horizontal	**Kerb return design at intersections -** The shape and radius the kerbline follows through an intersection has great impact on the maximum vehicle size which can access streets, given these bends are often sharper than the horizontal alignments of most streets. Traditionally, kerblines through intersections have followed a circular shape, with radius of between 1m and approximately 12 meters. Wider carriageways (and those with on-carriageway car parking) can generally	• AT have developed a standard for a 'compound kerb return', which has been adopted for an increasing proportion of new intersections which support left turns in Auckland as part of the TDM. Rather than following a circular design, the shape features a varying radius which follows the tracking of the design vehicle. The vehicle can follow its natural path without providing an unnecessarily large intersection area, which would encourage greater smaller vehicle speeds, while also more effectively balancing pedestrian crossing distances and support for larger vehicles.

Type of deflection	Traffic calming device and description (Based on AT TDM[24])	Considerations for emergency services
	support larger vehicles with a smaller radius than a narrower street would need. Current trends are towards narrower carriageways. The primary benefits of smaller radius returns are generally seen as: • Shorter crossing distances for pedestrians • Reduced vehicle speeds through the intersection, reducing crash risk and severity with both other vehicles and crossing pedestrians.[26] • Reduced intersection size	• The smallest design, the residential compound curve, provides significantly better tracking than the 7m radius circular kerb return previously endorsed by AT. This most compact option is designed to support the AT 10.3 meter truck, which is comparable in size and maneuverability to the FENZ Type 4 Aerial appliance. The larger option, the commercial compound curve, is designed to support much larger vehicles.
Horizontal	**Pedestrian refuges, median islands and build outs -** AT TDM standards require a minimum lane width of at least 2.7 metres for local streets, and at least 3.0m on collector and arterial streets to be maintained, including around median islands. In addition to this, clearance must be provided between the lane edge and any kerbline, such as those of a median island, to ensure that larger vehicles can travel unimpeded.	• There is a lack of robust evidence in the literature on the impact of refuges, islands and build outs directly on emergency services. Further investigations are required. • AT standards require a minimum 500mm clearance envelope between a 2.5m wide vehicle and any vertical kerb on either side[27]. The largest vehicles in the FENZ Appliance guide are 2.5m wide.
Horizontal	**Narrow traffic lanes -** Achieved through mechanisms such as: • extending the footpath • adding bollards or planters • adding a bike lane or parking. The lane width standards outlined above are also applicable to general traffic lane width.	• AT requires all street designs to be trackable by a 10.3 m truck, which is similar in size and maneuverability to the FENZ Type 4 aerial Pumping appliance. Consider working with AT to ensure that this is applied to all designs and also work with them further regarding scenarios in which additional space maybe required to distribute equipment such as the boom.

[26] https://nacto.org/publication/urban-street-design-guide/intersection-design-elements/corner-radii/

[27] AT Transport Design Manual, Urban and rural roadway design, p. 29

Type of deflection	Traffic calming device and description (Based on AT TDM[24])	Considerations for emergency services
Horizontal	**Chicanes and Build Outs** - These devices create a horizontal deflection which requires vehicles to slow to navigate turns around them. A short section of single two-directional lane also further slows vehicles which have to give way to oncoming vehicles. These devices also create a level of uncertainty, unless signage is provided, as to who gives way which has an associated traffic calming effect.	• The TDM standards used by AT as outlined above for refuges and islands also applies to these types of devices. Consequently, the same level of clearance applies which would cater for larger FENZ vehicles such as the Type 4 Aerial Appliance. • One consideration is that these types of devices could be beneficial for emergency service vehicles as they are largely immune to the uncertainty effect of having to give way.
	Modal filters – Types of modal filter can include: • allowing vehicles to continue through a section of street in one direction only • allowing vehicles to turn left into or out of a street from an intersection, while employing a median barrier to prevent right turns • preventing any through traffic at a four-way intersection with a diagonal barrier across the intersection, such that all traffic must turn • removing vehicle access through a section of street. Walking and cycling are generally supported unimpeded through modal filters. Modal filters are typically arranged on a street network to make local streets and communities safer. By reducing traffic volumes and encouraging mode-shift, walking, cycling and public transport trips are relatively more direct and safer. Networks of modal filters can be designed to operate together to dis-incentivise through traffic, creating what are known as Low traffic	• A study of the introduction of various networks of Modal Filters (arranged to create LTNs) on emergency services in London in recent years has found no evidence that response times have been affected by such schemes, either on remaining through routes nor on the streets which have been

Type of deflection	Traffic calming device and description (Based on AT TDM[24])	Considerations for emergency services
	neighbourhoods (LTNs). Depending on design and location, such schemes may effectively reduce the number of vehicle trips enough that traffic on the remaining through routes is unchanged or even reduced. Alternatively, capacity on through routes may be increased due to simplification of intersections and removal of traffic movements and queueing through them.	
	Pedestrian Malls - Pedestrianising a street removes all vehicle traffic from that street. These are only considered in areas of high pedestrian activity such as city and larger town centres. These are common overseas including in Australia (especially in Brisbane[28]) and can be managed	• These can lead to mode-shift and behaviour change improving overall road safety in areas with high volumes of vulnerable users. • Their implementation can lead to simplification of intersections and associated reduced delay through them. • Local emergency access can be retained through provisions such as vehicle ramps at entrances, removable or retractable bollards and considerate street furniture positioning. Recent examples in Auckland include Queen St[29].

[28] https://www.brisbane.qld.gov.au/laws-and-permits/laws-and-permits-for-businesses/queen-street-and-valley-malls-management/queen-street-mall

[29] https://akhaveyoursay.aucklandcouncil.govt.nz/waihorotiu-queen-street

Recommendations

Vertical Deflection

- It is recommended that FENZ develop a nuanced and collaborative approach with AT for lifeline routes, which considers a range of various traffic calming options, and the advantages and disadvantages for emergency vehicle access, given the increasing range of devices available and how these are being adapted. For example, the Swedish ramps and compound kerbs outlined in Table 4.
- We suggest that initially FENZ agree the following principles with AT for lifeline routes
    - **Intersection device choice –** FENZ could work with AT on the specific device that is most appropriate for each intersection on a primary route.
    - **Vertical deflection on signalised intersections -** FENZ could consider supporting vertical deflection devices at signalised intersections as there is limited evidence that the device itself causes congestion and it is unlikely to cause noticeable delay to appliances given FENZ policy that appliances come to a full halt at signalised intersections.
    - **On side streets –** FENZ could support vertical deflection treatments on the entry into side streets as the delay associated with appliances slowing down to make a safe turn in and out of a side-street will be minimal.
    - **Mid-block crossings on lifeline routes** – For mid-block locations FENZ should consider supporting vertical separation on signalised crossings and zebra crossings if the area is a high-risk location for pedestrians. There are opportunities to work on the design of the table as noted.
    - **Overall design of vertical deflection on life-line routes** – Where vertical devices are agreed to be installed on lifeline routes:
        - FENZ could request that any vertical devices be **designed to the absolute minimum height and profile that achieves the desired effective speeds**. Using the minimum intervention is consistent with a precautionary approach that will minimise the potential response time delays and potential wear and tear impacts on FENZ appliances.
        - **Raised tables and safety platforms are the preferred** treatment. Humps and cushions are not preferred at this point as outlined in Section 2.1.3 there is just not enough research to date on this matter and raised tables are appearing to be a clearer preference).
        - Based on the research we have done, we would suggest asking AT if they would accept **75mm high ramps, with a 1 in 15 gradient**. This would produce the desired 30km/h speed outcome with minimal disruption and discomfort for emergency vehicles. For reference, AT's default standard is 100mm high humps at a 1 in 10 gradient.
    - **Traffic calming on secondary routes** – on secondary routes FENZ could work with AT to install and monitor different approaches to better understand the impact on emergency services response times.

Horizontal Deflection

- All new street designs in Auckland are required to be trackable by at least the Auckland Transport TDM 10.3m truck, which from our preliminary assessment offers very similar manoeuvrability to FENZs largest pumping appliance, the Type 4. Bus routes and arterials are required to support tracking for significantly larger vehicles than FENZ appliances. These standards cover intersections, bends, turning heads and traffic calming. Previous, outdated AT standards required tracking by a smaller vehicle in some cases; however, applications for such are no longer being accepted by AT. It is therefore recommended that ATs current horizontal geometry standards are sufficient to ensure effective emergency vehicle operation[30].

4.3 Benefits of traffic calming on response times

New Zealand has committed to decisive action on road safety under Road to Zero: New Zealand's road safety strategy for 2020–2030.[31] Road to Zero adopts a vision of a New Zealand where no one is killed or seriously injured in road crashes, and a target for reducing annual deaths and serious injuries by 40 percent by 2030. Vision Zero for Tāmaki-Makaurau Auckland is AT's ambitious transport safety vision that aims for no deaths or serious injuries on the transport system by 2050.[32]

- Between 2016 and mid-2022, vehicle crashes made up approximately 8.5% of all FENZ callouts. A reduction in deaths and serious injuries on the road could impact FENZ response times in a positive way. Fewer callouts to crashes means that there is likely to be reduced pressure on FENZ resources.
- Reducing the severity of crashes could also reduce the amount of time emergency services need to be in attendance and how long the roading network needs to be closed to deal with the response and subsequent investigation. The safe systems approach has been internationally adopted, including by NZ through Vision Zero. This approach is based on a range of evidence which demonstrates the implementation of measures such as reduced speed limits, traffic calming and others should lead to fewer crashes and less severe crashes[33].

4.4 Potential injuries to staff from traversing vertical devices

One of the concerns regarding vertical deflection measures is the potential Health and Safety risk to staff travelling over the devices:

- Injuries caused by the cumulative effect of having to drive over speed tables, cushions, and other vertical elements repeatedly
- Injuries associated with striking head on the ceiling of the appliance when driving over speed table at speed.

Research by the Transport Research Laboratory in the UK looked at the possibility of vehicle occupant sustaining an injury from a single or repeated traversing of road humps. The ligament forces were so far below the damage threshold, it was concluded that ligaments are unlikely to be affected. Although muscle tissue was not modelled explicitly, this implies that the muscles would also be very unlikely to be damaged under predicted loads. Similarly, the predicted forces on discs in a healthy spine were such that a healthy spine is unlikely to be injured by repeated traversing of a road hump and vertebral fractures are very unlikely to occur for those with normal bones. Based on those predictions, it is considered that vehicle occupants are very unlikely to be injured from single or repeated traversing of road humps. [34]

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[30] https://at.govt.nz/media/1985454/engineering-design-code-urban-and-rural-roadway-design-version-1.pdf

[31] https://www.transport.govt.nz/assets/Uploads/Report/Road-to-Zero-strategy_final.pdf

[32] https://at.govt.nz/projects-roadworks/vision-zero-for-the-greater-good/

[33] https://www.jhsph.edu/research/centers-and-institutes/johns-hopkins-center-for-injury-research-and-policy/our-impact/documents/recommendations-of-the-safe-system-consortium.pdf; https://www.nzta.govt.nz/assets/network/operating/safely/doc/safe-system-presentation.pdf; https://austroads.com.au/__data/assets/pdf_file/0027/392067/Module_7-1_The_Safe_System_Approach.pdf

[34] https://trl.co.uk/uploads/trl/documents/TRL614(1).pdf

However, FENZ has noted that there has been a report of one FENZ staff hitting their head on the ceiling of the appliance and sustaining an injury. Other literature we came across from the US also mentions that there have been instances of emergency services staff sustaining injuries from striking their heads on the ceiling of the response vehicle after driving over a speed hump and provide suggestions on how to eliminate these preventable risks.

> *Speed humps hit by a fire truck at high speed can cause personal injuries, and a standing or unbelted firefighter can be tossed from a vehicle. Clear safety rules on response procedures and practices, adequate protective gear, safe driving, training and supervision can eliminate these preventable risks.*[22]

Recommendations

Some potential options to minimise the risk of staff striking their head on the ceiling if the appliance could be:

- Ensuring all drivers know the correct and safe speed that they can drive over the different types of vertical devices to minimise risk to passengers
- Work with AT on a set of standard vertical device construction details so appliance drivers have confidence knowing at what speed it is safe to traverse the device
- Work with AT to get information on the location and type of traffic calming devices on the network.

4.5 Effect of traffic calming on wear and tear of appliances

Examining the effect of traffic calming on appliance wear and tear is outside the scope of this study. We have however included some relevant findings in the literature review that we thought were worth highlighting.

At least one piece of guidance references the adverse effect vertical deflection elements can have on appliances, but unfortunately does not provide the original source

> *Case studies in Portland and other cities suggest repeated exposure to vertical traffic calming tools such as speed humps and speed tables may accelerate stress fractures of ladders, cabinets and other equipment and accessories.* [22]

Going forward, FENZ may want to consider the purchase of smaller vehicles to attend non-fire emergencies. NACTO suggests that:

> *A relatively small portion of calls responds to actual fires. Fire departments can purchase more ambulances. Ambulances are smaller and can more easily navigate through skinny streets and traffic calmed streets. Ashland, Oregon has adopted this practice. Their normal dispatch practice sends ambulances to medical emergencies not involving vehicle crashes. They send both ambulances and fire engines to motor vehicle crashes in case of fire or need to evacuate.*[35]

While ambulances may not be appropriate for FENZ (the guidance cited above appears to be US-focussed where ambulances and fire/rescue are often operated by the same organisation), FENZ may consider a longer-term strategy to replace the existing fleet with smaller, lighter vehicles with better acceleration.

[35] https://nacto.org/wp-content/uploads/2015/04/Best-Practices-Emergency-Access-in-Healthy-Streets.pdf

> *Most fire departments custom order new trucks. In newer American cities, fire apparatus is sometimes chosen on the assumption that all streets will be wide, and that many streets will be cul-de-sacs. By contrast, in older cities and towns, whether in Europe or the United States, fire apparatus and emergency response tactics are often adapted to handle the many existing narrow streets in these communities. Many older cities, such as Boston, San Francisco, Seattle, and many others, have hundreds of blocks of narrow streets. In these cities it is common to find local streets that have just 10 feet to 14 feet of clear width between parked vehicles, since these were typical dimensions for local streets in the United States before World War II. Fire departments in these communities typically purchase vehicles and adopt tactics that allow them to function effectively on these existing streets. Milwaukee, Wisconsin purchased fire engines specifically for older neighborhoods that have excellent turning radii. Piedmont, California ordered highly maneuverable fire engines for use in responding to fires on existing narrow streets in hillside neighborhoods. Departments that respond to fires and emergencies in rural and wilderness areas—especially in rugged mountain and forest terrain—often purchase vehicles that are designed to handle narrow, windy roads and tracks. [...] Given the expense involved in purchasing new equipment, and the relatively long equipment replacement cycles in many communities, communities may need to adopt both short term and long-term strategies. In the short term, use only street designs and traffic calming measures which accommodate the needs of current equipment, and in the long term, purchase new equipment that is more maneuverable and adaptable.*[36]

4.6 Traffic congestion

From our literature review, there is evidence that traffic congestion does impact response times. For example, a study in the UK that looked at response times specifically when traffic levels were lower during Covid lockdowns concluded that congestion was a key factor that negatively impacted response times[37].

What is less clear is:

- Whether specific levels of congestion result in specific delays. Is there a trigger point where congestion has an impact on response times? Is the relationship linear or exponential?
- How effective alternative mitigation measures to increase traffic capacity are on improving response times.
- What specific road design interventions can be put in place to help emergency services "bypass" congestion.

We have not been able to establish clear answers to these questions and would recommend a precautionary approach based on first principles. There are two areas where we have included some commentary.

<u>Increasing traffic capacity to reduce congestion</u>

Many studies have shown increasing traffic capacity i.e., additional traffic lanes, can provide some congestion benefits in the short-term, but over time those benefits are eroded, and the effect is that overall congestion gets worse in the longer-term. This phenomenon is called induced demand which is a catch-all term for relationship where the creation of additional road capacity to ease congestion is quickly filled up by new drivers changing their behaviour to take advantage of the lower level of congestion, leading to it also

[36] https://nacto.org/wp-content/uploads/2015/04/Best-Practices-Emergency-Access-in-Healthy-Streets.pdf

[37] https://www.wearepossible.org/latest-news/traffic-is-holding-up-emergency-vehicles

becoming congested. There are many studies[38] on this including The Fundamental Law of Road Congestion: Evidence from US Cities from 2011[39]. This is the reason why it is widely understood that you cannot build your way out of congestion by building more roads.

Road design that allows emergency services to bypass congestion

To a certain extent this is what the current approach is when appliances operate under their emergency sirens and lights. Emergency services bypass the normal road rules. However, to work effectively, roads and streets must be designed in a way that allows sufficient space for emergency service vehicles to pass congested traffic. Many of the following will already be familiar to FENZ:

- Special vehicles lanes e.g., bus and freight lanes do offer a bypass and are already well utilised by emergency services in Auckland.
- Painted medians can also provide a bypass., However, these are increasingly being removed to reallocate road space to other modes including special vehicles and cycle lanes.
- Mountable kerbs which have been used overseas as discussed previously.

4.6.1 Traffic calming - Does it cause congestion?

There is a concern that traffic calming can cause congestion because traffic calming makes traffic move more slowly. Slowly moving traffic causes congestion, and congestion impacts response times.

From our literature review and research, we consider that the answer to this question is inconclusive. There are case studies and research that provides evidence either way.

Some of the reasons given for how traffic calming reduces congestion are:

- By generating a consistent flow of vehicles, traffic calming can result in lower and more consistent traffic speeds which in turn helps reduce congestion.
- Implementing traffic calming can also reduce the volume of traffic choosing to use that road.
- Certain traffic calming devices can help traffic flow. Roundabouts, for example can be more efficient than standard stop-controlled intersections or signals, but the local road conditions determine whether they are appropriate in specific locations.
- Another tool is the "green wave". This is a form of traffic signal progression where traffic signals in close proximity to each other are synchronised to enable progress with less delay along a corridor through a sequence of green lights. As outlined in the AT TDM Urban Roads and Streets Design Guide[40] this can be used for a variety of purposes including assisting public transport and cycling. Internationally, there is emerging research on the use of green waves to assist emergency vehicles, however, it appears that it is mostly in the preliminary stages[41] .

However, there are arguments that while traffic calming might reduce the amount of congestion in the area in question by reducing the number of vehicles that choose to use that route, this may have the effect of shifting traffic onto alternative routes. In the case of low traffic neighbourhoods this might displace traffic onto arterial routes which also tend to be the most important routes for emergency services.

Overall, the evidence is probably weighted more in favour of traffic calming reducing overall congestion levels by making alternative modes more attractive, but more research is required to conclusively prove the case.

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[38] https://www.vtpi.org/gentraf.pdf; https://www.bloomberg.com/news/articles/2018-09-06/traffic-jam-blame-induced-demand

[39] https://pubs.aeaweb.org/doi/pdfplus/10.1257/aer.101.6.2616

[40] https://at.govt.nz/media/1987453/urban-street-and-road-design-guide.pdf

[41] https://elib.dlr.de/128822/1/sumo2019_bieker.pdf

4.7 Removal of minimum parking requirements

In 2020 the National Policy Statement on Urban Development (NPS-UD) introduced significant changes to planning rules around parking throughout NZ. It removes the ability of councils to set minimum parking requirements, meaning the provision of parking becomes a market decision influenced by a number of factors including proximity to centres or public transport, and the cost of land.

This is significant change and there are concerns about flow on effects that may potentially emerge. This has been raised by FENZ with particular regard to the fact that parking demand may spill onto the street causing the following problems:

- More cars parking on the street may narrow the road corridor making it difficult for appliances to negotiate them.
- Increased pressure on on-street parking may lead to illegal parking such as double parking, parking across fire hydrants and vehicle accesses, and parking in "No Stopping at All Times" zones, removing the turning/manoeuvring space appliances need.
- More cars parking on street may limit the amount of space appliances have to manoeuvre once they arrive at the site. This can for example mean it may be difficult to run hoses to the back units as there might not be sufficient space for some of the equipment to manoeuvre adequately

We have not been able to find any specific research on the impact of minimum parking requirements on emergency service response times or access to property. We see that as an opportunity, given the recent adoption of the NPS-UD, for some research to be undertaken on this topic by either FENZ or in conjunction with Auckland Council and AT. What is clear from the work that has been done, outlined below, is that the removal of minimum parking requirements needs to be, and typically is, part of a wider package of parking management tools that ensure that such risks as parking demand spilling on to the street are proactively managed.

It is understood that FENZ has already identified the importance of this in their submission to the draft AT Parking Strategy and particularly the need for more detail on how AT could mitigate such unintended consequences. Below we have outlined the types of mitigations that have been implemented overseas or are being recommended here as part of the proactive management of parking.

Supporting alternatives to car ownership

- The Auckland Unitary Plan, and specifically section E27.3 Policies[42], includes requirements for bicycle parking and associated end of trip facilities on site for larger developments to encourage mode shift.
- Provision of dedicated car share parking is an increasing trend by private developers (for example, Ockham developments[43]). Providing car share within a residential development supports residents to forgo car ownership while still enjoying the benefits of a car when needed.

Improved management of public parking

- The draft AT Parking Strategy proposes Comprehensive Parking Management Plans (CPMP) as a key tool for parking management in Auckland going forward. AT provides a useful summary document outlining the CPMP Framework[44] and this will be critical to managing any over spill parking demand that may occur.

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[42] https://unitaryplan.aucklandcouncil.govt.nz/Images/Auckland%20Unitary%20Plan%20Operative/Chapter%20E%20Auckland-wide/4.%20Infrastructure/E27%20Transport.pdf

[43] https://www.stuff.co.nz/life-style/homed/real-estate/120364121/new-apartment-developments-ditching-car-parks-for-postcarbon-future

[44] https://at.govt.nz/media/1988509/comprehensive-parking-management-plan-framework.pdf

- Nationally, Waka Kotahi released National Parking Management Guidance in December 2021[45], with specific reference to the NPS-UD. The guidance provides a framework that councils can follow to improve their parking management.

Street design

- The AT TDM includes emergency service vehicles as a key check design vehicle for turning and manoeuvring. This is a requirement for designs and clearly indicates the amount of space appliances require. This process can be used to initiate parking restrictions for example:
    - Restricting parking to one side of the street to maintain the required minimum carriageway width for emergency services.
    - Removing on-street parking on streets where the carriageway would become too narrow.
    - A combination of NSAAT markings and mountable kerbs to provide additional manoeuvring space particularly around corners and at roundabouts.
- Other practices from overseas include recommendations outlined in the NACTO report on best practices emergency access. This includes the statement: *"well-designed curb extensions at intersections prohibit motor vehicle parking and do not hinder access or turning. They generally aid emergency access. Where delay occurs, it is usually minor."* [22]

Recommendations

As FENZ have already begun to do, it is recommended that:

- Due to the lack of research, particularly in the NZ context, FENZ could encourage Auckland Council and AT to undertake research on the impact of minimum parking requirements on emergency service response times or access to property. There are several suburbs in Auckland where changes allowed by the NPS-UD can already be seen, Avondale being a good example. Collating baseline data for on-street parking utilisation and how this changes as the developments increase will provide clarity as to if, and how much, parking demand spills over on to street – something that is currently very unclear.
- Work with AT to determine what (if any) parking management strategies are being adopted to reduce the risk of parking demand spilling out on to the street. In particular, ensure that FENZ is included as a key stakeholder from the beginning of the development of any CPMPs.
- Continue to work with the AT Design and Standards Team on street designs to ensure that the emergency services check design is always implemented. This is also an opportunity to explore other street design techniques being applied overseas which are more targeted at emergency services.

4.8 Reducing speed limits

The reduction of speed limits is a well-recognised tool for improving road safety and forms a key part of Waka Kotahi's Vision Zero.[31] Speed is involved in more than 70% of injury crashes in New Zealand.[46] Speed also increases the likelihood of a crash in several ways. As speed increases, peripheral vision decreases, which reduces the chances of drivers to spot other road users, such as people walking or people waiting to cross the road.[47] There is a direct, causal link between speed and safety outcomes. Indeed, there are no other risk factors that have such a substantial and pervasive impact on safety as speed.[48] Speed limit reductions have been

[45] https://www.nzta.govt.nz/assets/resources/national-parking-management-guidance/national-parking-management-guidance.pdf

[46] Understanding the role of Speeding and Speed in Serious Crash Trauma: A Case Study of New Zealand | Published in Journal of Road Safety

[47] Katoa, Ka Ora, Tāmaki Makaurau Transport Safety Governance Group

[48] Guide-for-Road-Safety-Interventions-Evidence-of-What-Works-and-What-DoesNot-Work, World Bank Global Road Safety Facility (GRSF), 2021

found by Waka Kotahi to reduce death and serious injury rates. The magnitude of the reduction is dependent on the original and new speed limits (based on Nilssons Power Model); however, the effect is typically between 15 and 30%.[49]

Speed limit reductions do not affect emergency services, as they do not need to comply with speed limits during an emergency.

Research from London also found that reducing speed limits (in their case from 30 to 20 miles per hour) has no negative effect on air quality and reduces both particulate and carbon dioxide emissions.[50]

FENZ has expressed concerns with the potential cumulative impacts of reduced speed limits when combined with other traffic calming interventions. There is little evidence that a reduction in speed limits results in increased congestion, in part because average road speeds in cities are more determined by the frequency of intersections than speed limits.[51] An Austroads research project into the issues concluded that:

> *speed limit reductions would have the strongest impact on network operations (increased travel time, lower speeds, reduced casualty crashes) on roads with low levels of congestion and with few intersections. On the basis of the modelling, it can be concluded that speed limit reductions would have no appreciable effect on urban arterials during times of congestion.* [52]

4.9 Benefits of a compact city on response times

The NPS-UD among other planning changes has the broader objectives of building a more compact liveable city and minimises the need for suburban sprawl at the city's edges. There is evidence[53] that low density sprawl development increases emergency response times and resources required. For example:

> *In their 2006 study of traffic crashes in 122 U.S. counties in the U.S. National Highway Traffic Safety Administration's Fatal Accident Reporting System, Lambert and Meyer found that average emergency response times in ex-urban areas were greater than average response times in urban areas (10.7 minutes and 7.6 minutes respectively) (Lambert and Meyer, 2006). Moreover, in their regression model of emergency response times to 244 crashes, they find that greater population density is associated with lower response times.*[22]

As a population becomes more geographically spread out, the fringes of the city are further away. The only way of reducing travel times to the fringes is to create more stations that provide greater geographical coverage. Under compact city models, more of the population is within reach of well-located stations which means that responders are closer to incidents.

The other advantage of a compact city is that it is generally less reliant on private car travel. Density enables services to be located within walking and cycling catchments of more people. Public transport patronage can also support higher frequencies which makes PT more attractive. Overall, this means that roads are less

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[49] https://www.nzta.govt.nz/assets/resources/standard-safety-intervention-toolkit/standard-safety-intervention-toolkit.pdf

[50] https://content.tfl.gov.uk/speed-emissions-and-health.pdf

[51] https://www.wri.org/insights/need-safe-speed-4-surprising-ways-slower-driving-creates-better-cities

[52] https://austroads.com.au/publications/network/ap-t143-10/media/AP-T143-10.pdf

[53] Lambert, T. E., & Meyer, P. B. (2006). Ex-urban sprawl as a factor in traffic fatalities and EMS response times in the southeastern United States. Journal of Economic Issues, 40(4), 941-953.

Lambert, T. E., Srinivasan, A. K., & Katirai, M. (2012). Ex-urban sprawl and fire response in the United States. Journal of Economic Issues, 46(4), 967-988.

Trowbridge, M. J., Gurka, M. J., & O'connor, R. E. (2009). Urban sprawl and delayed ambulance arrival in the US. American journal of preventive medicine, 37(5), 428-432.

congested with private vehicles than they otherwise would be because people make those trips by walking, cycling, scooting or public transport.

These modes are also spatially more efficient than private vehicles which enables more people to be moved within the same road space. This could potentially enable more space to be freed up for emergency service vehicles. For example, bus lanes can be justified when patronage is high enough, and these bus lanes can in turn be used by emergency services to bypass traffic congestion.

Recommendations

- FENZ could consider future operating models that are aligned with the changes in land-use and development in NZ, including a potential rethink of the distribution of stations to better cater for places of increasing demand.
- Further, a review of the type of assets, in particular different vehicle types, could be considered. This is in recognition of the direction that land-use planning is evolving with denser building types and narrower more traffic calmed streets.
    - It is likely that both short- and long-term strategies will be needed considering the current FENZ fleet composition, appliance replacement cycles, and the pace of change in the transport network. FENZ (along with AT) could identify shorter-term traffic calming strategies that better accommodate the current fleet with an eye towards the long-term strategy where fleet evolution is an option.

4.10 Working with AT

There are some common themes that run throughout this report, one of which is that Road Controlling Authorities should work with fire and emergency services when they develop traffic calming schemes.

While most guidance documents recommend that road controlling authorities work with emergency services, what is not consistent is the best way to formalise this relationship and how emergency services should be involved in the decision-making process. Different approaches [22] [54] that have been used are:

- Some authorities give fire and emergency services veto powers over any traffic calming scheme or device.
- Some authorities have worked together with fire authorities to agree and formalise how they will work together and agree joint guidance that lays out the principles, design requirements, process and approach that will be used to inform decision-making.
- There are examples where road controlling authorities agree to install traffic calming schemes on a trial basis and monitor the impact on emergency response times.
- Other examples indicate that the relationship is more akin to fire services being a stakeholder. Fire services provide input into specific proposals and their views are considered alongside other stakeholders views.

Having to review and provide feedback on each traffic calming scheme that AT proposes is time and resource intensive. Furthermore, given the limitations of the available research and literature on the impacts of traffic calming on emergency response times it will be difficult to properly assess the effects of different measures on emergency response times.

Agreeing general principles and design criteria that are acceptable to both parties will increase AT efficiency in decision-making and reduce the resource implications for FENZ.

[54] Ewing, R., Brown, S. J., & Hoyt, A. (2005). Traffic Calming Practice Revisited. Institute of Transportation Engineers. ITE Journal, 75(11). 22 – 28.

If principles and design criteria can be jointly agreed, FENZ may not need to provide formal feedback to support specific interventions. FENZ will still need to be notified about the changes for planning and awareness purposes.

AT and FENZ's effort can then be concentrated on the proposals which fall outside the agreed principles and design criteria. In some cases, a trial and evaluation of the specific proposal may be the best option for determining whether the approach is appropriate. This would also give FENZ and AT an opportunity to be at the forefront of research on the topic.

As new proposals are evaluated, they can then be included into the formalised general principles and design criteria and over time the guidance can be refined and expanded.

Recommendations

- We understand that AT and FENZ have a good working relationship. Our recommendation is that FENZ investigate ways to work more closely with AT to agree and formalise some general principles and design criteria that AT can apply in their decision-making process
- A good place to start could be to align FENZ Emergency Vehicle Access and Appliance Types guidance with AT's TDM and resolve any inconsistencies.

5 Areas for Future Research

This report has demonstrated that the research around traffic calming, and compact cities more broadly, and the impact on emergency response is quite thin. There is little robust evidence on these topics despite them being concerns for decades. This places FENZ, AT, Waka Kotahi, and their partners in a situation where, if initiatives are monitored properly and data collected, policy can be informed robustly throughout New Zealand and the rest of the world in general. There are also other areas of concern for FENZ that could be investigated further that were outside the scope of this report.

The two areas of research could be as follows. First, is informing the literature on how traffic calming impacts emergency response in a robust and useful way for future policy making.

- This could be accomplished through case studies agreed upon with FENZ and AT. Interventions could be put in place strategically and data could be collected on things like traffic volume, speeds, FENZ response characteristics, etc. This would, in theory, allow for the impacts of the traffic calming interventions to be assessed robustly. To our knowledge this would be one of only a handful of studies taking an ex-post approach to analysing the interplay between traffic calming and emergency response. This would be similar in nature to the Manurewa case study presented in Section 3.3.1.
- By collecting more data, and more useful data, FENZ could likely pinpoint which devices work well and which do not for their emergency response. This would allow more informed discussion with AT and Waka Kotahi and allow for the tradeoffs between road safety and emergency response speeds to be more fairly evaluated. Ideally these findings could be used to develop a set of national guidelines.

The second category of research topics is an examination of other issues that concern FENZ but are outside the scope of this report. This includes (but is certainly not limited to) the following:

- Environmental impact of fires and fire burning duration. Not only does this potentially show a cost of delayed response but could also inform building code in the long-run.
- How changes in zoning and allowed density in Auckland will impact optimal station and/or appliance placement. As the city changes, the location of stations could become suboptimal. Similarly, equipment that was suitable for responding to standalone dwelling fires may not be appropriate for responding to townhouse/apartment fires. As the multi-unit typologies proliferate the city, how FENZ locates and supplies their stations could change.
- Does the changing face of Auckland (in terms of density and housing typology) impact the number/type/severity of callouts?
- How will increased density, and the presumed increase in callouts associated with that density, impact personnel requirements?

6 Summary

This report examined several important aspects of the intersection of roading policy/strategy and FENZ emergency response. Most importantly (and frustratingly), we found that the evidence around how traffic calming interventions impact emergency response times is lacking and often of poor quality. What good evidence that exists is mixed. Consequently, we are unable to make concrete recommendations about what the right and wrong ways to implement traffic calming are. That said, we have highlighted some useful pieces of knowledge from literature, first principles, and some quantitative analysis in Auckland.

While the literature is mixed, it is conclusive that emergency responders should be working directly with roading authorities to ensure that good outcomes are maintained. Of course, none of the literature describes what that looks like or how those good outcomes are ensured. But it does underscore the importance of working together and having robust dialogue.

We have also highlighted several types of traffic calming initiatives that are likely to be beneficial to FENZ's emergency response. These present opportunities for FENZ to be proactive in supporting AT and Waka Kotahi initiatives. We have made recommendations on how these strategic opportunities could get better outcomes for everyone – especially FENZ – while building a more trusting working relationship.

Our quantitative analysis demonstrated that, in the one area of Auckland where we can mostly isolate the impact of traffic calming, there is not much to report. It does not appear, so far, that effective response speeds to the impacted area have slowed any more than the effective response speeds to other areas. However, it has only been a short time, punctuated by various covid-related lockdowns and changes to how people travel and work. Further monitoring of this area – and any other areas that have traffic calming initiatives come online – will be vital to getting real-world data on the impacts.

We have also made recommendations about areas for future research. Some of this research is related to continuing to collect more and better data on things that we are already examining. But others are new areas of research related to, but separate from, traffic calming initiatives.

The recommendations contained in this report have been summarised in Table 5.

Table 5 Summary of recommendations

Area	Recommendation
Quantitative considerations	
Research and data collection	The research reviewed has highlighted the need for greater data collection and analysis. Where possible FENZ could seek to work with research teams to investigate, in greater detail, the impact of traffic calming interventions on emergency response time. Suggested areas for further research are detailed in section 5.
General traffic calming effects	As there is limited evidence on the general system impacts of traffic calming interventions, we suggest there is a need to work with road controlling authorities from a first principles perspective to build knowledge as it becomes available. We suggest evaluating interventions, possibly through well-monitored trials, to provide greater clarity on intervention impact on response time.
Qualitative considerations	

Area	Recommendation
Impact of traffic calming measures of reducing traffic accident rates and severity	The safe systems approach, adopted both overseas and by New Zealand as "Vision Zero", has the potential to reduce the likelihood or severity of crashes where traffic calming interventions are in place. While these interventions may impact response time, we recommend consideration is given to the potential for these interventions reduce requirements of emergency services to respond to incidents in these areas.
Traffic calming – horizontal and vertical deflection	While the safe systems approach above acknowledges the potential for reduced incident response requirements in areas with traffic calming, it is important for this to be balanced with careful consideration of emergency response time impacts of these interventions. We recommend the following: Horizontal deflection - ATs current horizontal geometry standards appear to be sufficient to ensure effective emergency vehicle operation based on comparisons of the TDM design truck with FENZ appliance sizes. Vertical deflection - It is recommended that FENZ develop a nuanced and collaborative approach with AT for lifeline routes, which considers a range of various traffic calming options, and the advantages and disadvantages for emergency vehicle access, given the increasing range of devices available and how these are being adapted. Refer section 4.2 for further detail on specific vertical deflection types.
Benefits of compact cities	We recommend FENZ could consider future operating models that are aligned with the direction that land use planning is moving in NZ, including a potential rethink of the distribution of stations to better cater for places of increasing demand. Further, a review of the type of assets, in particular different vehicle types, could be considered. This is in recognition of the direction that land-use planning is evolving with denser building types and narrower more traffic calmed streets.
Minimum parking requirements	As FENZ have already begun to do, it is recommended that: Due to the lack of research, particularly in the NZ context, FENZ could encourage Auckland Council and AT to undertake research on the impact of minimum parking requirements on emergency service response times or access to property. Additionally, FENZ could work with AT to determine that parking management strategies are being adapted to reduce the risk of parking demand spilling out on to the street. In particular, to ensure that FENZ is included as a key stakeholder from the beginning of the development of any CPMPs. Continue to work with the AT Design and Standards Team on street designs to ensure that the emergency services check design is always implemented. This is an opportunity to explore other street design techniques being applied overseas which are more targeted at emergency services.
Potential injuries to staff from Traversing vertical deflections	Some potential options to minimise the risk of staff striking their head on the ceiling if the appliance could be: • Ensuring all drivers know the correct and safe speed that they can drive over the different types of vertical devices to minimise risk to passengers

Area	Recommendation
	• Work with AT on a set of standard vertical device construction details so appliance drivers have confidence knowing at what speed it is safe to traverse the device • Work with AT to get information on the location and type of traffic calming devices on the network.
FENZ and AT	We understand that AT and FENZ have a good working relationship. Our recommendation is that FENZ investigate ways to work more closely with AT to agree and formalise some general principles and design criteria that AT can apply in their decision-making process A good place to start could be to align FENZ Emergency Vehicle Access and Appliance Types guidance with AT's TDM and resolve any inconsistencies.

Appendix A Mapping the Data

While this was not part of the contract with FENZ, we have created some data visualisations using the callout data received from FENZ. This appendix shows some of these visualisations and demonstrates the types of future analyses that could be done with the data already being collected. What follows are several maps of the Auckland area demonstrating different aspects of FENZ operations. This is a sample selection of the types of maps/visualisations that can be produced.

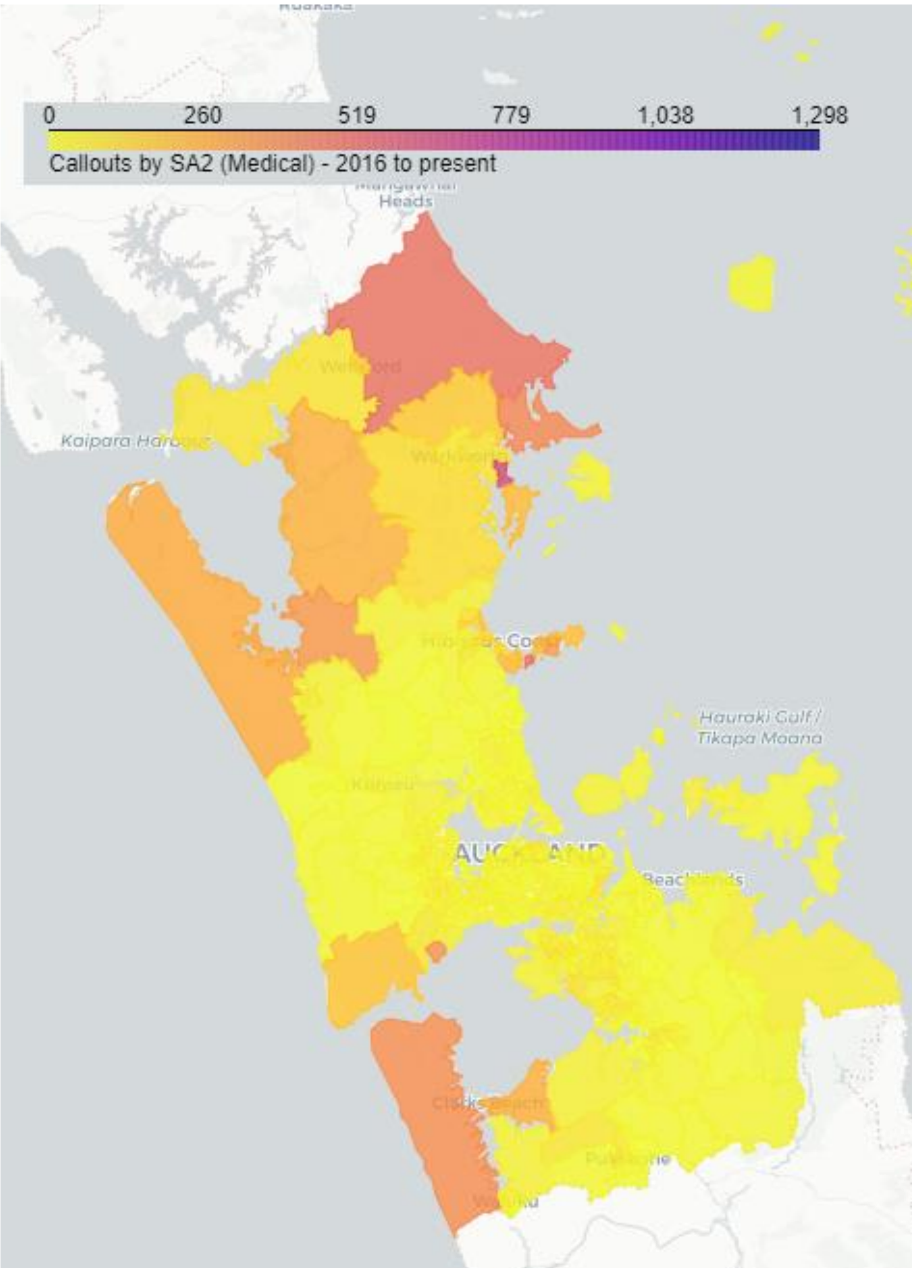

Figure 11 Medical callouts by SA2

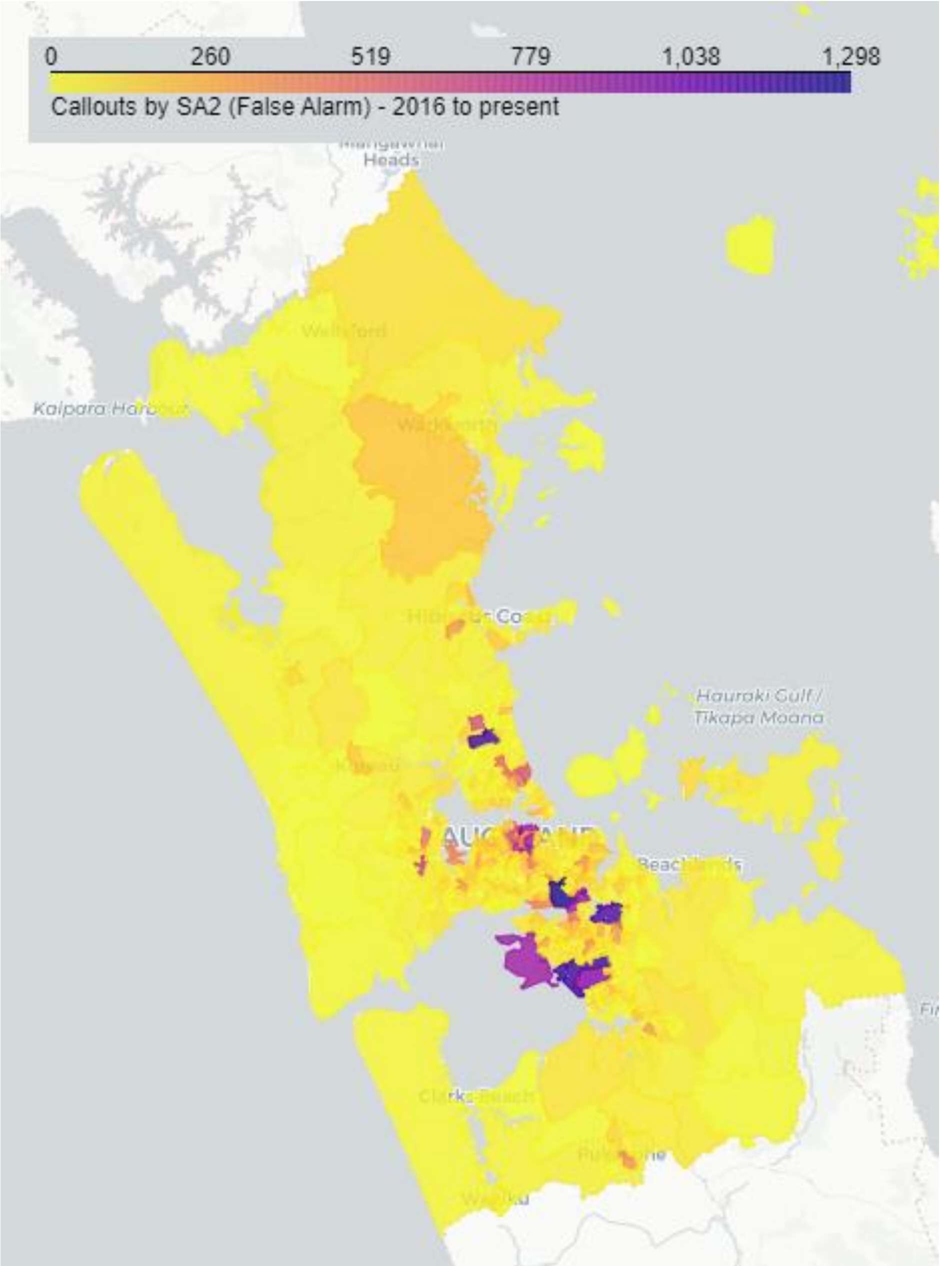

Figure 12 False alarm callouts by SA2

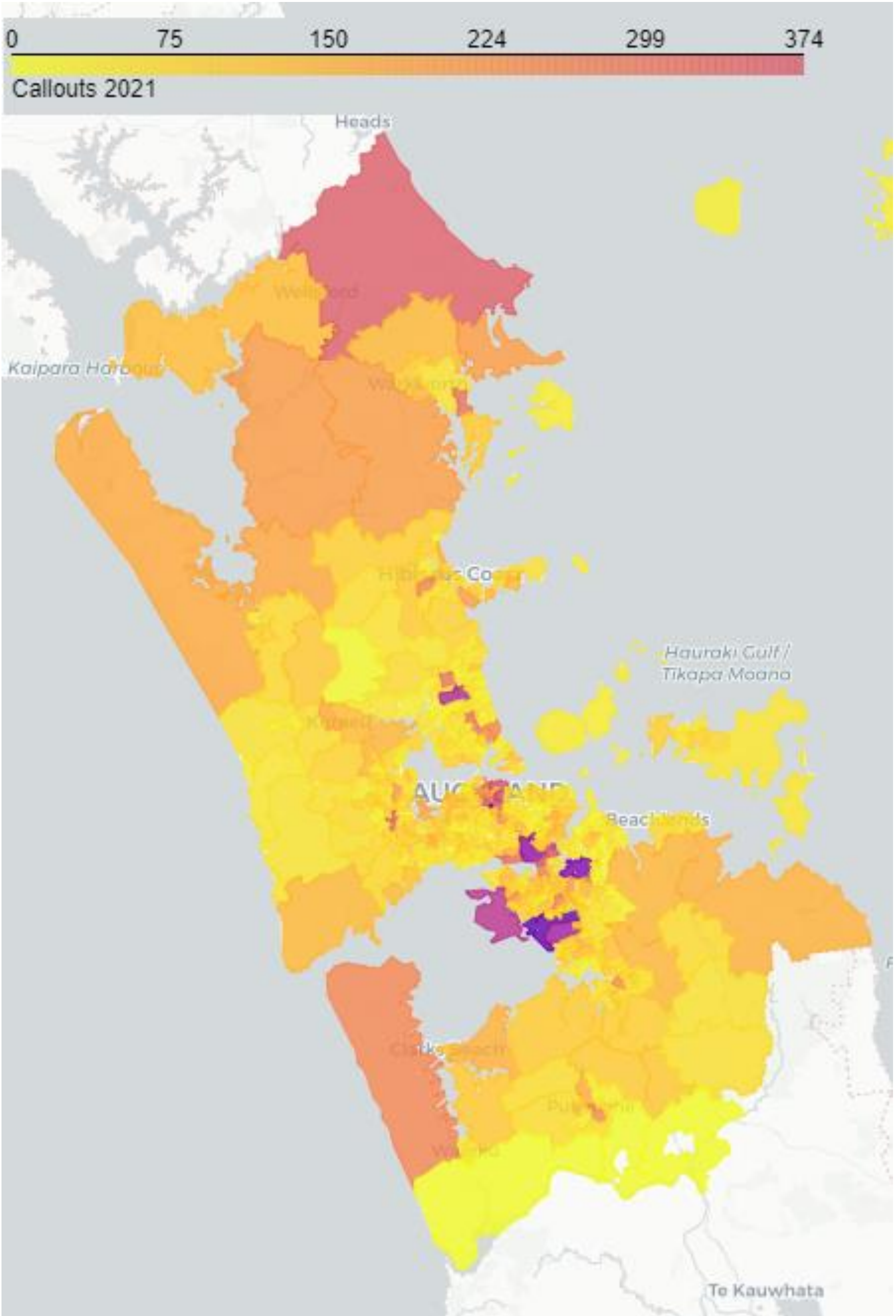

Figure 13 Total callouts in 2021 by SA2

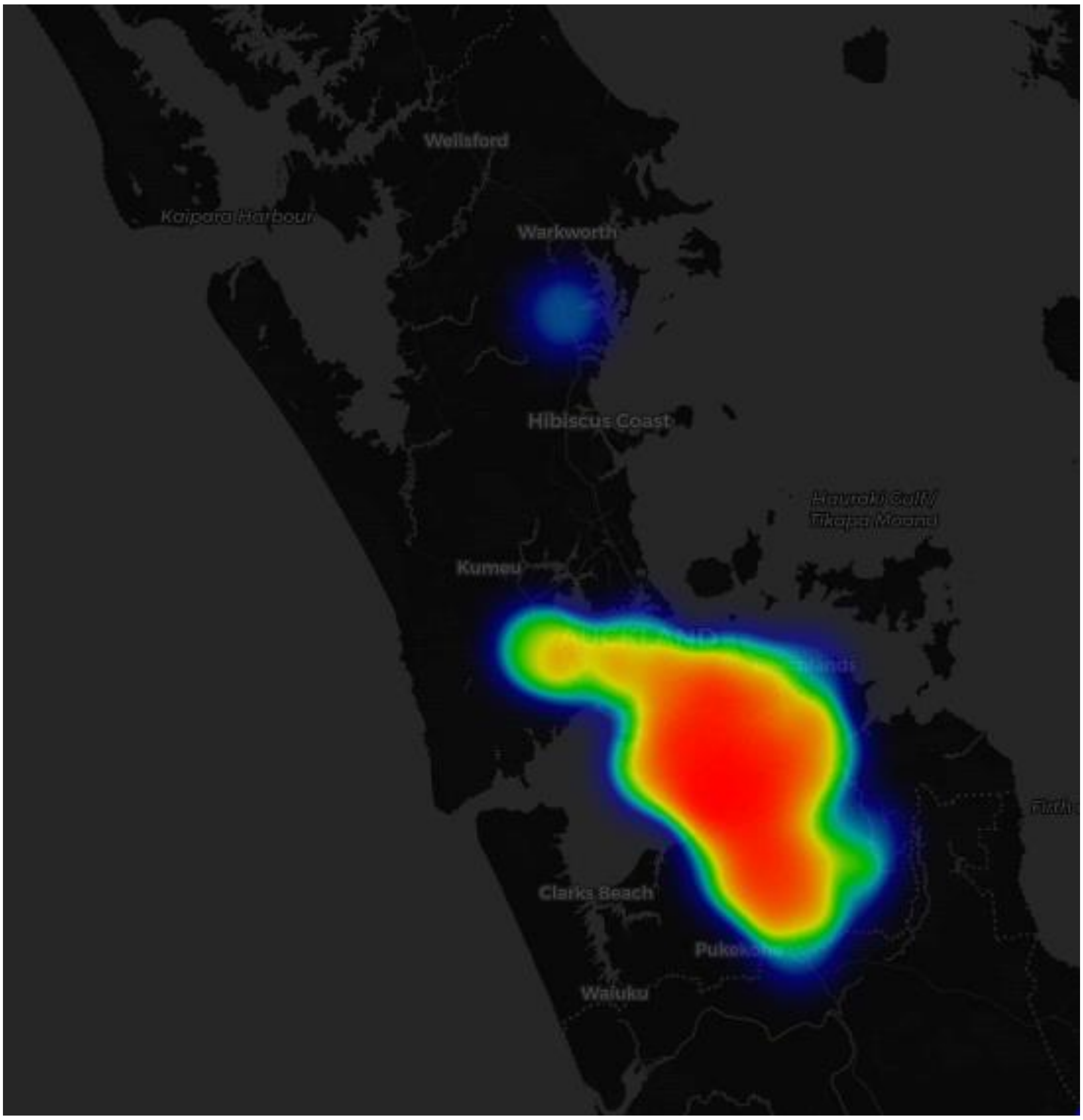

Figure 14 Heatmap of callouts from Manurewa Station

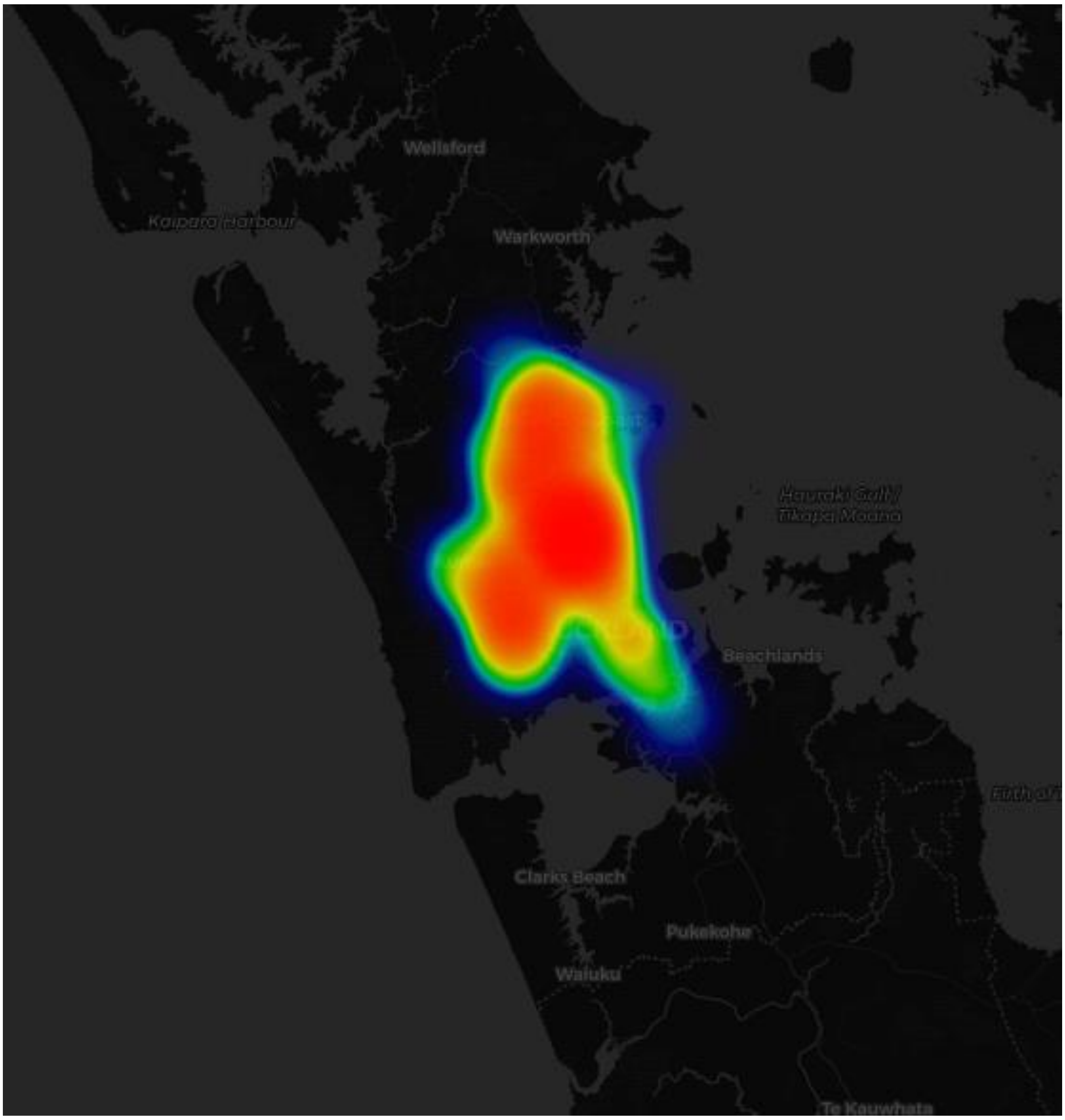

Figure 15 Heatmap of callouts from Albany Station

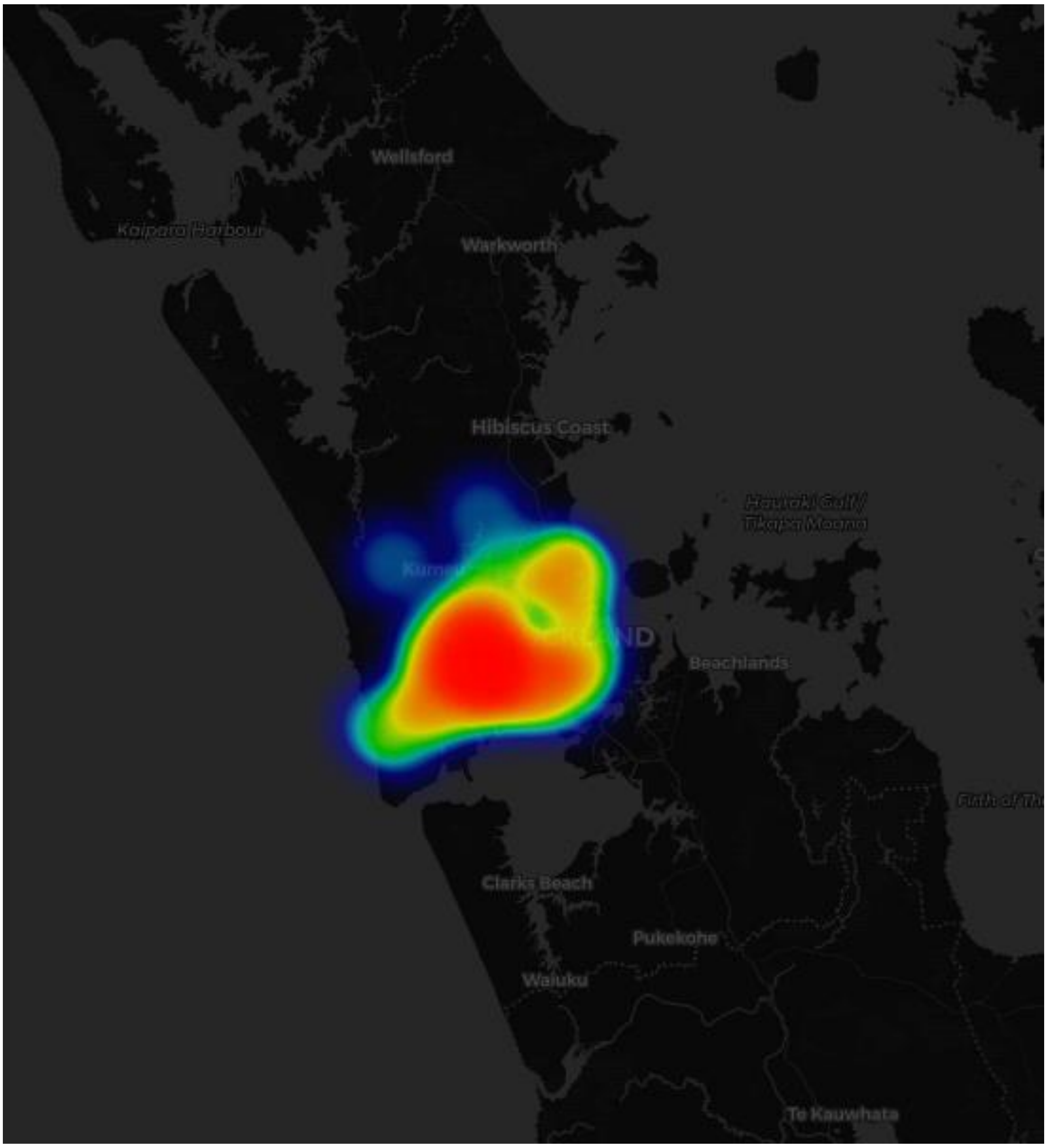

Figure 16 Heatmap of callouts from Henderson Station

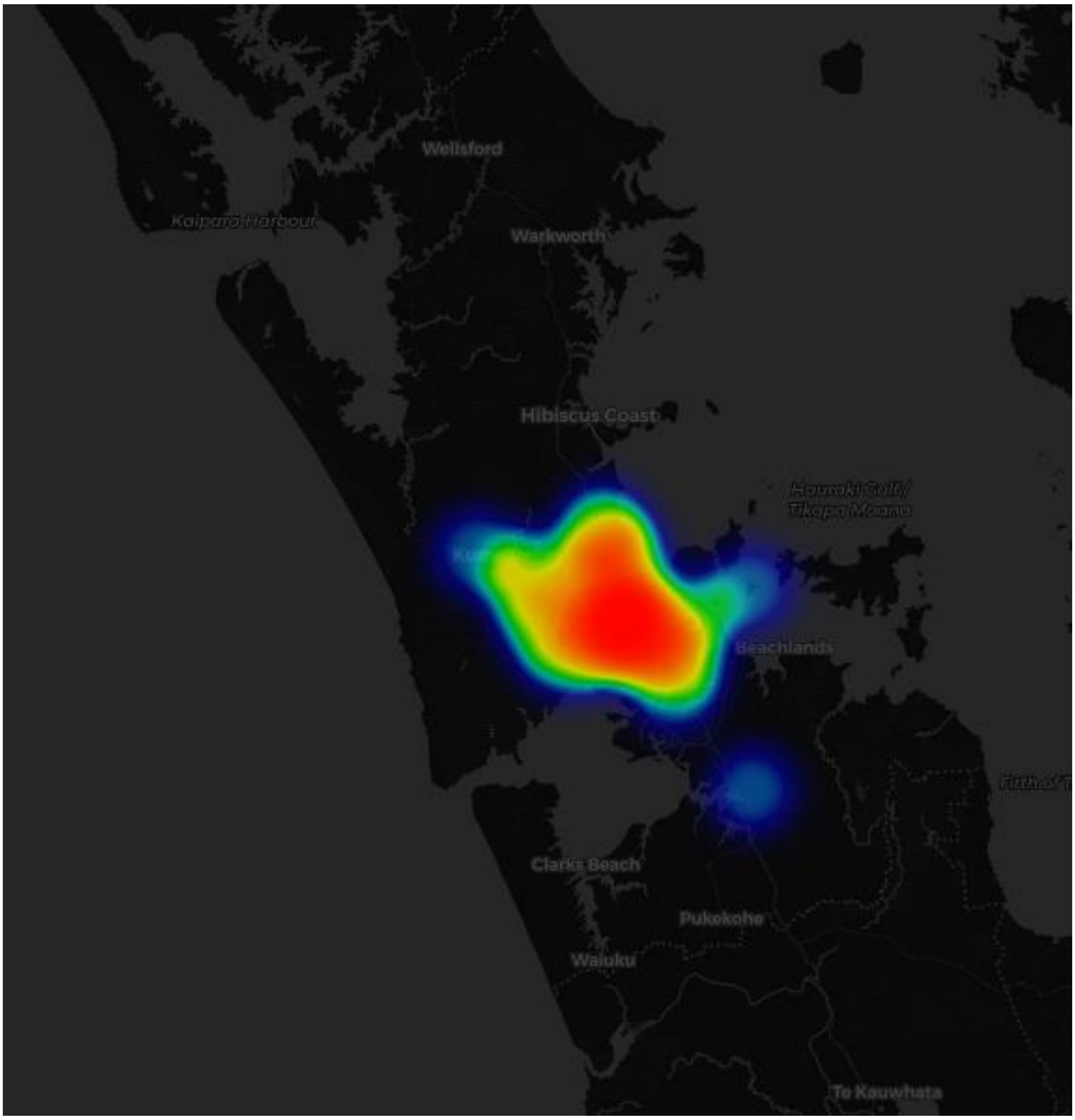

Figure 17 Heatmap of callouts from Auckland City Station