BUILDING BETTER HOMES, TOWNS AND CITIES
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Unlocking Transport Innovation: A Sociotechnical Perspective of the Logics of Transport Planning Decision-Making within the Trial of a New Type of Pedestrian Crossing

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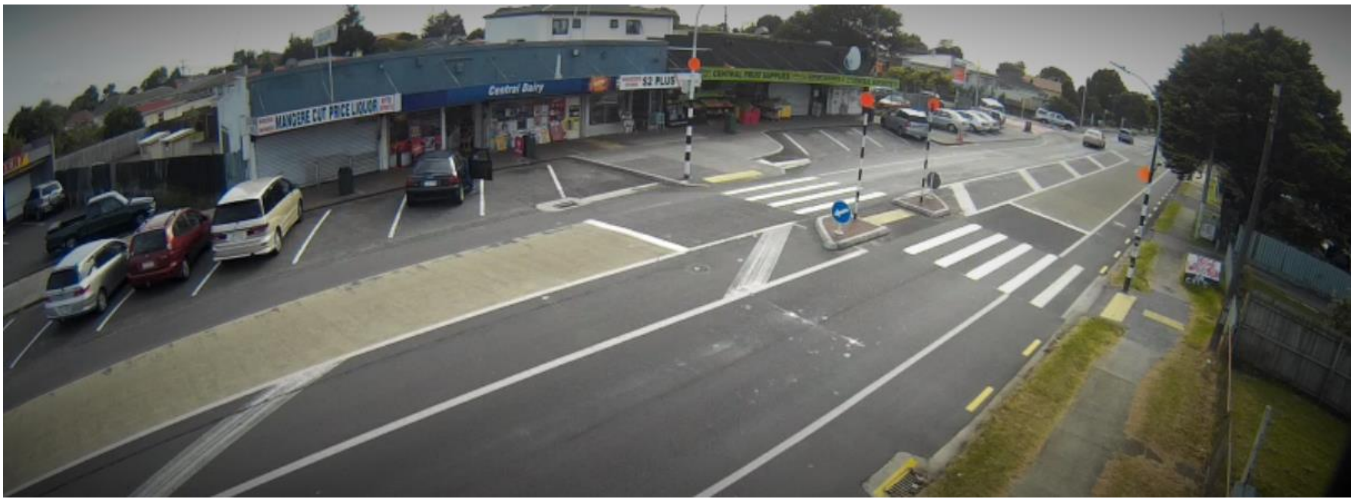

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Executive Summary

1 Introduction

This paper considers the proposal to install a novel type of pedestrian crossing, as part of a neighbourhood intervention, to investigate the architecture of decision-making that influences the delivery and outcomes of our urban environments. While political and policy-making directions often signal a movement towards providing better active transport options and safer urban environments for pedestrians and cyclists, delivering projects that achieve such goals can prove challenging, time-consuming and be marred by conflict. Innovative projects can stagnate, diminish in scale or fail to be realised entirely. The exact causes of these less than ideal outcomes are difficult to determine as they involve a complex sociotechnical assemblage of various actors, institutions, resources and logics. The architecture of decision-making that surrounds these projects is created through a myriad of de jure and de facto actors that, in concert, affect the material construction of neighbourhoods and shape our homes, towns and cities

In Auckland, the regional Road Controlling Authority (RCA), 'Auckland Transport' (AT), dedicates a chapter in its 'code of practice' outlining its commitment to enabling innovative solutions where appropriate. Yet, as political demands for a modal shift towards active and public transport have gradually intensified, the organisation has sometimes struggled to adapt from 'business-as-usual' practices that prioritise goals associated with the private motor vehicle, such as road network capacity and flow efficiency (particularly, alleviating peak hour congestion problems).

2 Aims

The aim of this paper is to understand the regulatory and decision-making logics, processes and practices that determine the street design solutions that become part of our built environment and transport infrastructure. Within this paper we deploy a sociotechnical framework to draw attention to the network of complex and multi-scalar relationships that compose a multi-actor innovation project. The research was conducted to address the following questions:

(1) What are the critical logics that inform the decision-making processes and practices that influence the outcomes of transport planning projects?

(2) How did these decision-making logics interact with the proposal for, and ultimate rejection of, the trial of an innovative type of pedestrian crossing on Massey Road, as part of the Te Ara Mua – Future Streets intervention?

3 Case Study

The case study for this research is the proposal and subsequent rejection of trialling a new pedestrian crossing on Massey Road, as part of the Te Ara Mua – Future Streets intervention, that occurred in the Auckland suburb of Māngere between 2014 and 2018. Future Streets is a transdisciplinary project involving a collaboration between researchers, practitioners and the local community aimed at providing a safer and healthier suburban neighbourhood. Through a community engagement process, the speed of traffic, confusion about road user priorities, and a lack of safe crossings – especially on the busier arterial roads – were identified as local traffic concerns impeding walking and cycling. A neighbourhood-scale intervention was designed and constructed and before and after measurement of residents' transport behaviour undertaken to determine the efficacy of the intervention, and the potential benefits of replicating similar projects in other areas. However, significant delays were experienced during the design phases of the Future Streets collaboration and this included decision-making to confirm final designs for the Massey Road crossings.

The decision-making around the pedestrian crossing designs provides a useful case study for investigating the interplay of factors – de jure, technical and social – that operate within and between organisations to maintain business-as-usual practices. No judgement is made on the merits or otherwise of the proposed crossing designs, or the decision to reject them. Our purpose is to examine the decision-making process and consider the implications of the process for the uptake of innovation in urban transport infrastructure.

4 Methodology

This research is informed by an assemblage methodology, by which the networks of people, practices and places involved in street design decision-making will be viewed as a co-constituted sociotechnical network. The term 'sociotechnical' collapses the dichotomy of the social and technical and moves research beyond simple binary descriptions of the relationship between society and technology. An assemblage methodology emphasises the ability of different but related systems to adapt or transform to disruption. So while the business-as-usual approach to transport planning may represent an apparent stasis, when understood as an assemblage, everyday activities must constantly maintain particular logics, processes and practices. This work is unexceptional and routine, yet plays a critical part in maintaining and reproducing specific systems and outcomes.

Our study included a detailed textual analysis of documents related to the provision and trialling of traffic control devices (TCDs) (i.e., pedestrian crossings) from both the New Zealand Transport Agency (NZTA) and Auckland Transport (AT), as well as materials related to the Future Streets project itself, such as, planning and design documents. Eight interviews were also conducted with representatives of AT, the NZTA and the research team – all involved at various stages of the design, review and approval seeking process for the Massey Road crossings.

5 Findings

The findings from the interviews and textual analysis provide a detailed account of the logics, processes and practices that informed decision-making relating to a failed proposal to trial a new type of pedestrian crossing within a neighbourhood intervention project. A synopsis of the four key logics and associated processes and practices revealed through the analysis is provided below.

- Framing problems and solutions

  The theme of seeking '*solutions before problems*' was apparent in dialogue with multiple national (NZTA) and regional (AT) transport decision-makers. This rhetoric was often invoked as a framing logic for identifying the legitimacy of solutions, with innovation being defined as the moment when a solution becomes married to an existing problem. Through the assessment process for the proposed Massey Road crossings, they became framed by AT and NZTA decision-makers as not beneficial enough to warrant being introduced onto the road network as an additional crossing type.

  Framing new ideas in relation to pre-defined transport problems limits space for innovation because it ties the search for solutions to a restricted perspective of what constitutes a 'problem'. This problem-framing and solution-seeking logic within AT and NZTA decision-making is structurally organised at the scale of the individual traffic control device (TCD). Consequently, neighbourhood and regional scale problems, such as those related to broader health problems linked to low levels of regular physical activity, that can be influenced by transport planning decision-making, can be overlooked and potential solutions missed. The framing of transport problems and the flow from problem to solution is not necessarily linear or straightforward – with particular framings of a 'problem' engendering a preference for specific forms of 'solution'.

- Consistency

  The logic of 'consistency' emerged as having been influential within decision-making regarding the proposed crossings. The technical design specifications of the proposed crossings required the sourcing and connection of several new component devices. This requirement generated the potential for disruption to existing sociotechnical relationships, which led to resistance actioned through micro-level politics within institutional processes. Consequently the crossings became framed as inconsistent and a potential legal and financial risk.

  The logic of consistency is built upon a requirement for predictability and calculability and the pressure of legal accountability. The threat of legal action presents a significant impediment to the trial of new technologies, as opportunities for innovation are measured against the potential for exposure to legal prosecution. This framing is likely to compel attachment to existing designs. The decision to introduce a novel solution is liable to attract significant attention should any negative outcomes eventuate – such as an accident on a section of road undergoing a trial. Consequently, designs that are framed as 'consistent' with existing solutions are likely to be labelled 'safe', whereas those framed as 'inconsistent' are likely to attract much greater scrutiny and be viewed as a potential 'risk'.

- Shared ownership and collective agreement

  The logic of 'shared ownership' encourages the embedding of technology within particular existing sociotechnical relationships; for example, relationships between designs, technologies and regulations with project planners, traffic engineers, construction contractors and their suppliers. Specific types of devices are supported through these relationships and their association with particular shared logics, expectations and practices. Consequently, existing TCDs generate 'ownership', a form of sociotechnical obduracy that is resistant to sources of disruption. The proposed trial of a new type of pedestrian crossing presented a source of disruption to existing sociotechnical relationships and consequently met significant resistance to its approval. This resistance cannot be attributed to any particular social connection or technical requirement, but is a co-product of relationships between both the social and the technical within the transport assemblage.

These relationships are maintained through an adaptivity inclined to stability and a reassertion of solutions that utilise existing technologies. Institutional technical requirements, such as AT's traffic resolutions 'sign off', emphasise collective agreement. However, the pressure to achieve a solution that is jointly 'owned' and collectively agreed can have significant impacts on the mobility of new ideas. An implication of prioritising the search for collective agreement is that it can galvanise institutional inertia, making it difficult to allow for innovation.

- Risk-avoidance and conservatism

Risk is a logic of overt significance but also has underlying importance within most, if not all contemporary transport planning decision-making. Identifying, managing and avoiding risk are key concerns within transport planning decision-making. Because the outcomes of trials of new designs and practices can be difficult to calculate and predict, they can be viewed as a liability. Consequently, there exists an inherent conservatism within transport decision-making and a preference for designs and practices that are already socially and technically entrenched.

However, this inherent conservatism is arguably a strong factor in limiting opportunities for innovation within the transport sector. Organisational structures and practices limit exposure to legal and reputational risks through limiting decision-making responsibilities of individual managers and engineers. This aversion to risk also significantly limits the space for innovation and for responsive adaptation within projects to suit the specific needs of individual communities.

6 Space for Innovation

A number of conclusions can be drawn about the obduracy of existing solutions to transport planning problems and the challenge of creating space for innovation. This research demonstrates several logics, processes and practices relevant within transport planning decision-making and the generative potential of a sociotechnical assemblage perspective. A number of further conclusions relevant to wider studies of decision-making, governance and planning can be made:

- Innovative proposals must capture and address clear policy problems to convince key decision-makers of their value. Otherwise, an 'ownership' of existing solutions matched with shared logics of consistency and risk-avoidance can cause proposals to be framed as inconsistent and undesirable.

- There is a strong demand for calculability and predictability within transport decision-making to address the demand for financial and legal accountability. Consequently, hierarchies of authority and responsibility have developed to manage risk and protect individual decision-makers from exposure to legal and reputational consequences. However, risk management hierarchies leave little space for innovation and adaptability, and encourage business-as-usual outcomes.

- The scales at which decision-making is segmented within an organisation impact on the types of problems identified and solutions offered. Contemporary transport problems demand integrated solutions at neighbourhood and regional scales. Yet, governance hierarchies within transport planning segment decision-making and limit the scale of design and assessment. Thus, the potential for innovation at larger scales is reduced.

1 Introduction

The aim of this paper is to understand the complex 'architecture of decision-making' that transforms regulatory and decision-making logics, processes and practices determining the street design solutions that become part of our built environment and transport infrastructure. This research has been conducted as part of the Building Better Homes Towns and Cities National Science Challenge. A goal of this challenge is to expose and question taken for granted practices and business-as-usual approaches to urban problems. Consequently, through developing a better understanding of the complexity of urban problems, potential pathways to change can be identified. This study contributes to Building Better Homes Towns and Cities through interrogating the decision-making that directly impacts upon the design and construction of streets and neighbourhoods that are the routine spaces of daily life. The research addresses the following questions:

- What are the critical logics that inform the decision-making processes and practices that influence the outcomes of transport planning projects?
- How did these decision-making logics interact with the proposal for, and ultimate rejection of, the trial of an innovative type of pedestrian crossing on Massey Road, as part of the Te Ara Mua Future Streets intervention?

The Future Streets Neighbourhood Intervention

Future Streets is a transdisciplinary project involving a collaboration between researchers, practitioners and the local community aimed at providing a safer and healthier suburban neighbourhood. Alongside the local community and mana whenua[1], the stakeholders in the project included a multi-disciplinary research team drawn from transport planning, urban design, social science and public health. Working with the researchers to fund and complete the physical works for the project have been practitioners and decision-makers from Auckland Transport (AT), Auckland Council (via the Māngere-Ōtāhuhu Local Board), and the New Zealand Transport Agency (NZTA). The focus of this neighbourhood-level intervention is the networks of roads and pathways that both mobilise and link the local community together, but also act to *territoralise* (Jessop *et al.*, 2008) as they bind and enclose local space (Addie, 2016). As a transdisciplinary project, Future Streets aims to integrate community, policy and research knowledge and to assess a range of outcomes from the design intervention. The research team hope that measuring changes in transport behaviour and rates of traffic-related injury before and after the intervention's completion will establish the efficacy and potential benefits of undertaking similar projects in other neighbourhoods.

Massey Road is a busy arterial road running through a residential area in Māngere, Auckland. During community consultations undertaken for a street redesign intervention study – Te Ara Mua Future Streets – the installation of pedestrian crossings on Massey Road emerged as a priority for Māngere residents and the Pukaki Marae community. Innovative crossing designs were proposed and subsequently rejected for Massey Road, and ultimately standard crossings were installed. The

[1] The local indigenous people (Māori) who have historic and territorial rights over the land.

decision-making around the pedestrian crossing designs provides a useful case study for investigating the interplay of factors – de jure, technical and social – that operate within and between organisations to maintain business-as-usual practices. No judgement is made on the merits or otherwise of the proposed crossing design, or the decision to reject them. Our purpose is to examine the design-making process and consider the implications of the process for the uptake of innovation in urban transport infrastructure.

Putting Policy into Practice: Everyday Decision-Making

The contribution of this paper is in applying a sociotechnical assemblage framework to explore urban governance focused on the micro-level politics of everyday decision-making – the regular, routine and unexceptional work embedded within institutional practices and knowledge regimes that generate the eventual outcomes of policy-making at the macro-political scale. Thus, within the context of a neighbourhood-level transport planning intervention, this research examines the everyday work practices and logics of transport engineers, their 'tools of trade', and the regulatory provisions, organisational values and processes and professional norms that shape the decisions they make. It also examines the interface between central-local government roles and responsibilities in determining the approval or rejection of non-standard street treatments/devices. Accordingly, in-depth interviews were conducted with Auckland Transport engineers and managers, New Zealand Transport Agency engineers/managers and members of the Future Streets research team. The emphasis in these interviews was on understanding the norms and practices that cohere to support the maintenance of business-as-usual, rather than barriers to innovation per se.

Paper Structure

The structure of this paper is as follows. Following this introduction, Section Two presents the case study for the research. The context of Te Ara Mua Future Streets neighbourhood intervention is briefly outlined, including a number of transport issues identified by the local community, and the project's goals in seeking to resolve them. Secondly, this section provides an account of the proposal, delay and eventual rejection of the application to trial a new type of pedestrian crossing on Massey Road, a busy arterial road bisecting the suburb of Māngere. Section Three introduces the methodological framework for the study. A brief account of the growing interest in a sociotechnical assemblage perspective within urban studies is provided before the component parts of the framework are considered. Assemblage theory and its emphasis on relationality and fluidity is discussed. The term sociotechnical and its implications for research into transport decision-making is then examined. The argument is made that a sociotechnical assemblage account of transport planning encourages a micro-political assessment of the everyday decision-making that translates macro-level policy-making to the ground level. The methods used within the research to address its analytical concerns are presented in Section Four. Section Five introduces the findings of the research, including the four key decision-making logics identified within the research, and their associated processes and practices. Section Six presents the conclusions from the research and broader implications for studies of decision-making and urban governance.

2 Case Study

Te Ara Mua Future Streets and the Massey Road crossings

The proposal to install new pedestrian crossings on Massey Road arose out of a community engagement process undertaken as part of Te Ara Mua Future Streets (TAM-FS)[2]. The translation of Te Ara Mua is "the future path" and this name represents a core goal for the project and its stakeholders: to innovate, to do something different in order to demonstrate the possibilities for future transport planning and its connection to the needs of local communities. The design of the project reflects a growing recognition of the challenge of introducing innovative solutions to transport problems at a neighbourhood scale. In Auckland, the regional Road Controlling Authority (RCA), 'Auckland Transport' (AT), dedicates a chapter in its 'code of practice' to outlining its commitment to enabling innovative solutions where appropriate (Auckland Transport, 2017). Yet, as political demands for a modal shift towards active and public transport have gradually intensified, the organisation has sometimes struggled to shift from 'business-as-usual' practices that prioritise goals associated with the private motor vehicle, such as road network capacity and flow efficiency (particularly, alleviating peak hour congestion problems) (e.g. Wilson, 2017; 2018).

Auckland is one of many 'new world' cities that have become characterised by low-density sprawl and the predominance of motor vehicle-orientated transport investment (Mees, 2009). The primacy of the motor-vehicle as the main form of transportation has well demonstrated negative health consequences, however the geography of the impacts of this travel behaviour is uneven. The Future Streets project is centred in Māngere, a suburb of Auckland, New Zealand. Māngere is a lower socioeconomic suburb. Its predominantly Maori and Pasifika residents experience high rates of traffic related injuries[3] and non-communicable diseases (e.g., diabetes). By redesigning street infrastructure in Māngere, the Future Streets project aims to increase residents' levels of walking and cycling and change driver behaviour, thereby improving the health and wellbeing of Māngere residents.

Engagement with the local community has been a central tenet of the Future Streets project. This engagement entailed a community design phase that extended beyond the level expected by Auckland Transport. Understanding how local people travel around Māngere and their aspirations for change were important aspects of this work. Transport-related issues identified by the community included: speed of traffic affecting their perception of walking and cycling safety, confusion about road user priorities, and a lack of safe crossings – especially on the busier arterial roads (Mackie *et al.*, 2018).

The Future Streets collaboration experienced a number of challenges, primarily relating to lack of clarity around the roles and responsibilities of the different parties, varied estimates on the funding

[2] The research component of Future Streets was funded by the Ministry of Business Innovation and Employment ($M 3.4) and the intervention was funded by Auckland transport, New Zealand Transport Agency and Auckland Council (via the Māngere- Otahuhu Local Board) ($9M).

[3] Māngere ranks fourth out of 275 Auckland communities for fatal and serious crashes, with 26% of all crashes in the area involving pedestrians. The estimated social cost for the Māngere area is around $18.2 million (https://at.govt.nz/projects-roadworks/te-ara-mua-future-streets/)

available for the invention and delays during the design phases of the project (Witten *et al.*, in press). A critical source of delay was the process of decision-making in order to reach final design confirmation for the devices used in the intervention, including designs for the Massey Road crossings.

Massey Road crossings

Through the community engagement process, the provision of pedestrian crossings along Massey Road, an arterial road that bisects the suburb, became a clear objective for increasing the safety of the local road environment, as well as increasing the opportunities for active travel behaviour within the neighbourhood (such as, walking and cycling). As part of the intervention, the proposal to install multiple pedestrian crossings along Massey Road was identified as a priority for mana whenua (the local Māori community). Providing pedestrian crossings, a form of traffic control device (TCD), for the community was critical, as at the time the road had only two controlled crossings across the busy 3km section and a speed limit of 60km/h, 10km/h higher than standard residential streets (due to its designation as an arterial road). The road therefore presented a substantial barrier, dividing the marae papakainga (a form of community housing) from the local school and mall. To reach these everyday amenities tamariki (children) commonly had to cross a busy road without the aid of TCDs.

To demonstrate the potential of new ideas for solving persistent traffic problems, as well as to stretch the intervention budget as far as possible, the research team proposed a new type of TCD for the Massey Road crossings. The pedestrian crossing designs were proposed based on evidence of their efficacy from examples in North America, and their high level of safety and potential for substantial cost savings in terms of both installation and maintenance over existing solutions[4]. Cost savings would primarily be achieved through the proposed crossing's simpler design. Analysed in detail later, the existing solution requires the installation and networking of multiple automated sensing and flashing devices, both on the side of the road and embedded within the road surface. In contrast, the crossing designs proposed for Massey Road are manually activated by a pedestrian wishing to cross and do not contain lights embedded within the road, thus achieving savings in installation and maintenance (see Appendix A).

However, while the new crossing type was originally included within the plans for Future Streets, the complex regulatory decision-making process required for their legal approval – that is, the focus of this paper – significantly delayed their installation. The research team wished to measure the intervention's impact on local resident behaviour, however, within the confines of a four-year funded research project, the delay in gaining approval for the crossings threatened to compromise their data. By mid-2016, the project had passed its anticipated competition time frame without having completed construction of the Massey Road crossings, or conducted the follow up data collection for the research component. Consequently, plans to trial the new crossing type on Massey Road were abandoned, and a proposal to install existing types of pedestrian crossing (already approved under the Land Transport Rule) made instead. However, since the crossings were to be installed on a road with a speed limit of above 50km/h, approval from the NZTA was still required. This approval took a further six months to

[4] Estimates of an installation price were around NZ$30,000 for the proposed design compared to around NZ$200,000 to install the TCD currently allowed under the Land Transport Rule: Traffic Control Devices 2004.

be granted, so that construction of the crossings was only possible from early 2017. The construction of three crossings along Massey Road was completed by mid-2017, with the Future Streets opening celebration held 7 July, 2017. The crossings eventually installed were two ‘augmented’ pedestrian (‘zebra’) crossings and one signalised pedestrian crossing.

3 Transport Decision-Making as Sociotechnical Assemblage

Providing reliable and effective devices to facilitate people to cross roads safely is an important part of providing permeable and safe urban environments for communities. However, the needs of local communities and the decision-making objectives of transport governance do not always align. To explore the decision-making logics, processes and practices within transport governance, this paper draws on and further develops a conceptual toolkit that has provided new insights into the assembly and mobility of policy-making within urban governance. Related theoretical developments within several traditions have helped to contribute to the investigation of the processes and practices of urban policy-making and governance. There is now a growing literature that challenges incumbent understandings of technological change as purely technical, neutral and apolitical (Maassen, 2012). The commonality within this literature is a shift in attention towards relationships rather than actors. Actors, in this sense, can be anything that can affect something else, and so the primacy of the individual as the only agent that can enforce stability or change is displaced. The relationships are, essentially, networks of influence that extend out from each different actor. It is through the assembly and disassembly of these networks of influence that particular outcomes are produced. Within urban studies, this type of analysis has recently become broadly associated with the term 'assemblage'.

Assemblage theory

Assemblage thinking has been posited as a promising analytical conduit towards a better grasp of the complexities that generate certain policy outcomes over others (McCann & Ward, 2012). Assemblage has developed as one of several concepts within a constellation of theories concerned with networks and relationships between both human and non-human actors. Although developments within cultural economy, material sociology, and science and technology studies (STS) each have their individual theoretical trajectories and particular disciplinary proclivities, arguably there remains considerable overlap in their application of assemblage thinking (Müller & Schurr, 2016). The term 'assemblage' has come to broadly denote the theoretical foundation of methodological approaches of this type within studies of urban governance and policy-making (Baker & McGuirk, 2016). The original development of assemblage theory is broadly attributed to the work of Deleuze and Guattari (2011), however use of the concept within social research is mostly divorced from the broader spectrum of the authors' theoretical work.

Experimentation between extant urban theory and assemblage theories has not been unproblematic (see, Brenner, Madden & Wachsmuth, 2011). Thus, there is a need for careful consideration in the methodological application of assemblage theory within research (Baker & McGuirk, 2016; McFarlane, 2011a). However, the promise of assemblage in shifting focus from the outcomes of decision-making to the 'how' questions of policy practices – searching for the processes that (de/re)stabilise certain logics, paths, networks and practices – is to provide a greater appreciation for the complexities that generate such outcomes (Baker & McGuirk, 2016). The use of this term within the field has mostly been in a descriptive sense, aimed at emphasising the composite and relational aspects of policies, practices and the material construction of urban spaces. For example, McCann and Ward (2012: 43) explain that they use the term in a descriptive sense to "encourage both an attention to the composite and relational character of policies and cities and also to the various social practices that gather, or draw together, diverse elements of the world into relatively stable and coherent 'things'". However, it is crucial to move beyond assemblage's methodological insistence on beginning with thick description (McFarlane, 2011b; McGuirk *et al.*, 2016), to allow the mapping of relationships and networks to inform a set of subsequent analytical concerns (Anderson *et al.*, 2012).

Essentially, the study of urban assemblages allows us to open up black-box arrangements – an unveiling of the actual practices, processes and sociotechnical networks, as well as the distributions of resources, of powers and of agent capacities that cause certain actors, things or processes to be made present or absent within the built environment (Farías, 2011). Perhaps even more critical, through drawing our attention to the emergence, relationality and mobility of urban assemblages, such methodologies can also reveal and invite us to consider the fragility of these networks and the potential for alternative configurations to emerge.

The sociotechnical perspective

The term 'sociotechnical', as it relates to an assemblage methodology, deserves further clarification. Sociotechnical collapses the dichotomy of the social and technical and moves research beyond simple binary descriptions of the relationship between society and technology (Vreugdenhil & Williams, 2013). The social – human relationships, politics, shared expectations and understandings, everyday patterns, habits and practices, roles and responsibility, *etc.* – and the technical – devices, electrical and communications systems, interconnected components, physical artefacts, companies, financial and legal systems, *etc.* – are, instead, considered as a 'seamless web' (Hughes, 1986). This 'seamless' network of relationships connects social and technical elements at multiple scales. The micro-level everyday social practices and interactions do not form a background to the macro-level progression of scientific and technological trajectories, but are, instead, a co-constitutive part of the forming, functioning and rupturing of these networks. Equally, the micro-level dynamics of sociotechnical relationships are therefore essential in translating and activating policies and political-framings mobilised at a macro-level.

Simply put, the sociotechnical perspective highlights the tension between the potential fluidity of existing relationships and their equally apparent durability. An assemblage understanding of sociotechnical networks emphasises that existing relationships are temporary and in constant negotiation – that they are in a perpetual process of (re)generation and (re)configuration (Anderson *et al.*, 2012; McFarlane, 2011b). Yet, these relationships can also prove durable, and can – for a time, at least – develop a form of obduracy (Hommels, 2005): a consistency, and an institutional inertia towards the reproduction of particular outcomes (Lovell & Smith, 2010). It is this obduracy, inertia or 'lock-in' (Callon, 1998) of the transport sector to particular traffic control devices that is the focus of this paper. Thus, to interrogate the obduracy of particular devices used on the road network it is necessary to consider the decision-making logics, processes and practices that enable particular sociotechnical relationships to be held stable.

When applied to the context of decision-making within transport planning, the sociotechnical assemblage perspective underscores the 'work' of maintaining particular practices and systems. Assemblage emphasises the fluidity of systems and their "adaptivity rather than fixity or essence" (Venn, 2006: 107). So while the business-as-usual approach to transport planning may represent apparent stasis and inertia, when understood as an assemblage, constant work is required to (re)assert and (re)produce particular logics, processes and practices. The connections that form are only allied in their co-functioning and are therefore always susceptible to ruptures and adaptations (McFarlane, 2011a). Thus, while decision-making can appear to follow path-dependant trajectories, it is problematic to ascribe these trajectories with intent and rationality in a straightforward way (McCann & Ward, 2012). This work is unexceptional, such that the 'policy assemblage' is constructed through the mundane and seemingly trivial nature of everyday decision-making (Prince, 2010: 172). However, it is exactly these routine forms of action that are critical in the constant co-constitution of sociotechnical networks and, thus, establish an important locus for analysis.

4 Methods

In this study, assemblage methodology was utilised to discover and critique the decision-making process in an neighbourhood intervention project primarily involving a regional transport planning organisation and a group of researchers. Concepts associated with a sociotechnical perspective were used to consider the ways in which common decision-making logics and processes (re)produce business-as-usual practices and limit capacities for innovation.

Analysis within an assemblage methodology demands thick description and empirical detail (McFarlane, 2011b; McGuirk et al., 2016) to allow the mapping of relationships and networks, and to inform subsequent analytical concerns (Anderson *et al.*, 2012). Our study therefore included a detailed textual analysis of documents from both the New Zealand Transport Agency (NZTA) and Auckland Transport (AT) related to the provision and trialling of traffic control devices (TCDs) (i.e., pedestrian crossings), as well as materials related to the Future Streets project itself, such as planning and design documents. Eight interviews were conducted with representatives of AT, NZTA and the research team. Interviewees were chosen based on their involvement at various stages of the design, review and approval seeking process for the Massey Road crossings. Pseudonyms that reference the role of each interviewee are used. These pseudonyms do not relate specifically to the position each participant holds, but are used to provide an approximate understanding of their role within the decision-making process.

Of the eight interviews, six were conducted face to face and two by telephone. Each interview lasted around one hour. Signed consent to participate was obtained from all interviewees. Interviews were recorded and transcribed in full. After close reading of the interviews by the authors, emergent themes were identified and a coding frame was developed and used to code the interview data. Nvivo 11 software (QSR International, 2015) was used to assist with data management. Analyses of the data were undertaken by the lead author and the findings are reported in the next section.

A semi-structured interview schedule was used to guide the conversations with interviewees. The objective of the interviews was to understand the business-as-usual decision-making processes that are applied when approval is sought for new traffic devices. Specific attention was given to understanding the logics that cohere to support the maintenance of business-as-usual practices, rather than barriers to innovation *per se*. The interview questions were asked in two parts. The first group of questions related to the interviewee's involvement with the Future Streets projects and the process of designing, assessing and implementing the devices to be used within the intervention – focusing on the Massey Road crossings in particular. The second group of questions asked each interviewee about their role within their organisation, what their everyday work practices were, as well as their 'tools of trade' and responsibilities.

5 Findings

Framing problems and solutions

In regard to decision-making concerning new traffic control devices (TCD), a shared logic across both AT and NZTA was the importance of defining an existing transport problem that any proposed device would seek to solve. Both interviewees involved in the assessment of new TCDs from within AT and the NZTA argued that there needed to be a clear rationale for introducing something new onto the road network. As a NZTA Traffic Devices Manager reiterated, a key frustration for him is:

> *People coming up with solutions which don't have problems … we are open to innovation and ideas but we are not looking for solutions that aren't fixing a problem.*

Referring specifically to the NZTA's 'Traffic Note 10', which contains the guidelines for trialling TCDs, there are certain things he looks for from a Road Controlling Authority (RCA) when making decisions regarding the trialling of such devices:

> *So basically there has to be a problem, so often we get solutions looking for problems, we get people wanting to try flashing stop signs and all these sorts of things. So what is the problem to start with?*

Clearly then, in deciding to approve the trialling of a new device, he needs to be convinced that a problem exists with the current road networks and the devices used on it. '*Solutions looking for problems*' are essentially applications to trial devices, which, in his decision-making capacity, he believes have arisen from concerns that are not well-aligned with the NZTA's transport planning goals.

The Traffic Devices Manager for New Zealand's largest RCA, Auckland Transport, is responsible for the processes which legalise traffic controls (with membership of both the Transport Controls Committee (TCC) and the NZTA's Traffic Control Device Steering Group). His role makes him a key decision-maker within AT for introducing new TCDs. He makes a similar statement to those above regarding his considerations in the trialling of new TCD designs:

> *On the innovation side, yeah, it's about making sure that we don't … overreach and try and do too many innovative things, it's got to be a genuine need for something new. So, not just innovation for the sake of innovation.*

Innovation is therefore understood by both NZTA and AT Traffic Device Managers as a moment in which a solution becomes married to an existing pre-identified problem. This understanding may somewhat limit the potential for spaces of innovation, as the practice of innovation is conceptually tied to the search for solutions based on existing understandings and pre-defined concepts of what constitutes a 'problem'. Decision-making capacity is therefore closely tied to the capacity to frame what is or is not a 'problem' on the road network. The scale at which problems are framed can therefore influence the solutions likely to be offered.

The determination and framing of what constitutes a '*problem*' is further expressed by the AT Devices Manager in his comments regarding the proposal to trial a new type of pedestrian crossing on Massey Road:

> *So, there is already an option to put a row of LED lights across the road in front of the pedestrian crossing that flash and help to alert drivers that they have a pedestrian crossing coming up … [so] this one wasn't seen as … introducing enough new benefits compared to other … current controls out there to warrant going ahead.*

What is suggested here is that there is a certain threshold of 'necessity' that needs to be identified in considering whether the testing of a new device is warranted. The existence of a seemingly similar device already covered by the traffic controls rules, and already trialled and accepted by the NZTA for use on the network, led to the proposed new crossing type being defined as a '*solution without a problem*'.

However, there are arguably problems with the existing device suggested by the AT Devices Manager that allow for potential innovation and improvement. Some of these issues are identified by a member of the research team:

> *What we tried to sort of pitch was that [the existing] system can be unreliable and it is quite expensive and you've got maintenance issues when you have got to resurface the road.*

The existing approved crossing system involves a standard 'zebra' crossing augmented by pedestrian detecting devices connected to LED studs embedded within the tarmac of the road, and positioned both alongside and on the approach to the crossing (see Appendix B). The LED studs flash automatically if the system detects the programmed signature of a pedestrian wishing to cross. The new TCD offered for trial during the Future Streets project would be potentially cheaper and easier to maintain because it is manually operated by the pedestrian wishing to cross, and so does not require the expense of an automated detection system that is potentially prone to false positives. Furthermore, the proposed TCD would use flashing lights placed on the crossing marker pole (similar to a 'Belisha beacon') and would therefore not need LED studs embedded in the tarmac of the road.

Nevertheless, it would seem that the proposed crossings for Massey Road did not gain the acceptance of critical decision-making agents within AT or NZTA during its application process. Interview discussion regarding the reason acceptance was not achieved mostly concerned the lack of a need for a new crossing type, without dealing with the particular advantages or disadvantages of either – AT and NZTA TCD decision-makers appeared to minimise any potential benefits. The presence of an underlying design philosophy with influence on decision-making over the above rationale is indicated by the NZTA Traffic Devices Manager when discussing his assessment of the proposal:

> *…so why don't you want to do what everyone has agreed nationally that is the solution in this situation? And what is better about it other than it is cheaper. What is better about putting flashing lights up when we had all agreed that a driver's line of sight is more in the road space rather than having to look up?*

The importance of consistency is a logic that runs through transport decision-making, and is discussed later. The statement '*we had all agreed*' alludes to the drive for national consistency in transport planning. The importance of maintaining the driver's '*line of sight*' focused on the road is indicative of a design philosophy that has historically permeated transport decision-making internationally.

Transport modelling, as it is understood today, arose during the 1950s in order to make predications within the transport planning process (Timms, 2008). Johansson (2009) describes this traditional road design philosophy as 'accident focused', whereby the goal of road design is the reduction of traffic accidents. This model is also described in the interviews by an AT Traffic Engineer, who stated that transport planning in NZ has historically been encompassed by '*link road theory*'. His description of this type of planning closely aligns with the above definition, with emphasis on geometric calculations that inform precise predictions of road user actions and prioritise road environments that remove the possibility for surprise. An underlying purpose of standardisation through engineering calculations is to remove distractions and increase the visibility of the roadway for drivers, in order to 'safely' increase speeds and improve network efficiency and flow, while reducing the possibility of accidents.

There is a long established international critique of this philosophy for its emphasis on vehicular efficiency over residential liveability (Ben-Joseph, 1995). In response, there has been an uptake in new design philosophies that are people-focused; that is, they shift the priority from accident-prevention to fatality-prevention. Rather than attempt to reduce, as much as possible, the chance for a traffic collision to occur, it is argued instead that road design should work toward reducing, as much as possible, the physical bodily damage that a person undergoes in a collision event. In short, to ensure that roads, vehicles and transport services are designed so that "the level of violence that can be tolerated by the human being is not exceeded" (Johansson, 2009: 827). A key aspect of a fatality-prevention philosophy is therefore enforcing reduced speeds on residential roads and keeping drivers alert to the potential for surprise. An example of this philosophy in practice is Sweden's 'Vision Zero' policy and its growing influence on transport policy internationally. The 'self-explaining roads' (SER) design philosophy incorporated into the street design for the Future Streets project closely aligns with these goals.

The concept of 'good confusion' versus 'bad confusion' expressed by an NZTA Traffic Engineer below would suggest that this alternative philosophy is not completely absent from the NZTA's design practices. Similarly, the AT Traffic Engineer interviewed for this study also made reference to the fatality-prevention approach in the following statement, but he laments the commitment of transport planning in New Zealand to a conventional accident-prevention approach:

> *[T]he world has moved onto dropped speeds, let's deal with the fact that people are in environments and people make errors. And people are fallible and people cause problems. But instead what NZ has done traditionally is instead of going people cause problems, let's bring the speeds down to make sure that the vulnerable user is protected, we go "let's separate them and control the person who is vulnerable and stop them crossing or moving in the locations where you want them to move".*

The above statements suggest a tension within the New Zealand transport sector between traditional street design philosophies that prioritise driver line of sight to remove the potential for surprise at higher speeds, and contemporary critiques of these philosophies offered by 'Vision Zero' and SER.

Hence, the potential of the proposed Massey Road crossing for directing the driver's vision from the road, and surprising or confusing them, was framed by several decision-makers as a negative aspect of this design. By comparison, the current solution's use of LED studs in the road seemingly aligns better with existing expectations, irrespective of it incurring greater installation and maintenance costs and providing the potential for false positives (flashing when no one is waiting to cross) and false negatives (not flashing because people waiting cross have not been detected). From these differing perspectives, it would seem evident that the framing of transport problems is contested and so the flow from problem to solution is not necessarily linear or straightforward. The particular framing of a 'problem' engenders a preference for specific forms of 'solution'.

A significant amount of time and resources were spent by the project team to support the Future Streets project, and the proposal of a new crossing type. Describing the challenge of justifying the trial of a new crossing type, a member of the research team stressed how they endeavoured to convince AT engineers of its benefits:

> *[W]e went to a lot of effort to explain those benefits and we put all that in writing and emails and things like that. But firstly whether they read all of that properly and secondly whether they believed it, is another thing … but I think really fundamentally, I think some of these guys just simply thought their solution was a better one.*

Thus, a critical aspect in terms of trialling new ideas and supporting innovation becomes the everyday micropolitics of framing problems, and of convincing decision-makers to subscribe to a particular solution. Transport problems and their solutions are not common sense, nor is their assessment beyond subjective opinion, politics and vested interests. Particular framings of 'problems' advance one set of solutions over others, but the justifications for such solutions can be subject to path dependent practices and circular logics.

The theme of seeking '*solutions before problems*' was apparent in dialogue with multiple national (NZTA) and regional (AT) transport decision-makers. This rhetoric was often invoked for the purposes of framing the legitimacy or illegitimacy of specific technical solutions presented to them. Having a solution before identifying a problem was also expressed as a means of delimiting the appropriate spaces for innovation. The Project Manager (delivery) for the Future Streets intervention stated that in terms of making the case for '*doing something different*', he believes:

> *… one of the important things is that why we are trying to do something different and establish the case for doing something different. Now, if you've got that, it is a good foundation. So you need to understand why you are doing it … not doing it for the sake of it.*

Making the 'case' for innovation would seem to further suggest the need to convince decision-makers of a particular framing of a problem in order to negotiate a space for a solution to be offered.

In assessing the problems facing the Māngere community – and seeking potential solutions – it would seem there existed a disparity between the research team and AT decision-makers regarding the scale of the problem the intervention was being designed to solve. The research team were primarily focused on solving long-term health problems associated with low levels of physical activity, which led them to seeking solutions at a neighbourhood scale. Conversely, AT's decision-making systems are predominantly orientated towards identifying the acute risks of physical injury due to road traffic accidents. Hence, problems are framed at the scale of the individual device and whether it is likely to increase or reduce those risks.

Consistency

The logic of 'consistency' emerged as a significant influence within transport planning decision-making. As an analytical theme, the emphasis on consistency can be divided into two distinct aspects of time and space. 'Evolution not revolution' denotes the more temporal element of consistency in the introduction of new design solutions; in this case the framing of a solution as building upon an existing device and being coherent with the existing TCD design 'suite'. Secondly, consistency was also discussed in terms of a spatial justification – across the national road network. In this sense, consistency was expressed as an important design principle, justified on the basis that greater national consistency provides a more comprehensible network for drivers and reduces confusion.

Evolution not revolution

The discourse of 'evolution' over 'revolution' denotes a preferential framing of building upon existing traffic control systems and devices, rather than introducing something defined as a 'radical departure'. This justification is intimately tied to an overarching logic of increasing consistency. An 'evolution', for example, could be through a technical modification of an existing TCD design, whereby a traffic solution is enhanced to achieve better performance, or augmented to reflect a revised objective. Such considerations are suggested as an important part of decision-making. Below, The Traffic Devices Manager involved in assessing the new crossing type proposed for Massey Road described his deliberation on the proposal:

> *We already have so many devices for pedestrian crossings, what is the benefit of another one short of if you say there are some cost savings or something … So we thought well lets further develop what road users already know as a suggestion back to Auckland Transport rather than introducing another device.*

The evaluation made here is between the value of 'some cost savings' from a different type of crossing, versus the consistency for road users in using existing TCD types. The consistency gained through evolving existing solutions is also valued as an operating principle, i.e., by reducing the number of variables and unknowns transport planners are required to consider when making design and maintenance decisions. It is interesting that '*cost savings'* seem to be somewhat dismissed in this response, given the tight budget constraints of public organisations such as the NZTA and AT. This could indicate the strength of commitment to a logic of consistency that exists within transport planning.

The bureaucratic inertia that existing solutions carry can serve to devalue new ideas, designating them as divergent and unnecessary. The AT Traffic Devices Manager is responsible for overseeing the 'traffic resolution' approval process that legalises the devices used on Auckland's roads. As part of this process, he assessed the proposed new crossing type for Massey Road. His concerns with the proposed crossing type echo those above:

> *There [are] already other options for making a pedestrian crossing more recognisable and this one wasn't seen as … introducing enough new benefits compared to other … current controls out there to warrant going ahead.*

When asked how innovative ideas could gain acceptance within AT, he identified the value of evolving existing solutions:

> *Yeah, well if you … find an evolution of something … you can evolve a current control with, you know, the addition of some lighting might be required … it's making sure that the changes aren't so different that they're not gonna be understood. Evolution is better than revolution.*

Such expectations reduce space for potential innovation, as proposals must convince decision-makers of their novel contributions, while avoiding being framed as inconsistent with existing systems and devices. Thus, while the introduction of new devices is possible, TCD solutions that present a step change or paradigm shift in traffic control philosophy are unlikely to gain acceptance.

Despite the commitment to existing solutions, an AT Traffic Engineer involved with Future Streets during its design stage believed that such projects do offer potential 'safe spaces' around which innovation can occur:

> *So these projects, [are] like this bubble that you can work in and go, let's throw the norm out and do something unique and radical. We will evaluate it and do everything we can with due care to mitigate every foreseen risk … And let's create something new and do it.*

In this statement, the engineer positively expresses the potential for the trials in such projects to have an impact on future transport planning decisions. He suggests that projects like Future Streets can provide a place for trying '*unique*' and '*radical*' new traffic solutions. However, he tempers this statement, acknowledging a significant barrier to implementing these types of innovative solutions:

> *And then what you hit … is the legislation. You hit legislation which is very conservative and doesn't allow for trials without going through an extensive process which must then be applicable to the rest of the country.*

Clarifying his use of 'legislation', he specifies that certain entities within the NZTA and AT are concerned with the legal aspects of introducing a new TCD. As discussed below, these particular bodies are legally bound and liable for the outcomes of traffic resolutions processes and are, thus, inclined to be conservative towards proposed changes to existing designs and practices.

Local and regional

Consistency is a key concern within the decision-making process for both the NZTA and AT. The objective of consistency is often referenced in terms of how road users interpret the devices, signage and layout of the road environment. However, consistency has further purposes that are valued throughout the transport planning assemblage. Structural or bureaucratic consistency is also valued as it relates to improving the calculability and, hence, predictability of transport planning decisions. Both bureaucratic consistency and road user consistency are also seen as implicitly or explicitly interrelated, so that decision-making that affects one is often seen as impacting the other.

An NZTA Traffic Engineer described how consistency for the road user at the regional and national level is a key concern when assessing proposed TCDs. In the statement below, he outlines the importance to his agency of maintaining a high level of consistency:

> *…even suburb to suburb, so you don't confuse people as they travel around the region. I'm still having to think about that downstream effect. So as soon as you get out of Māngere Future Streets and there are pedestrians crossing the roads just as they are in Future Streets, but why are these facilities not for them – are they less important or do I speed up here?*

Specifically concerning the Future Streets project, he explains how decisions made for one project must necessarily be considered within the broader region. Therefore, the provision of a different crossing type in Māngere could cause confusion for drivers as they move into an adjacent suburb with standard crossing types.

As further explained by the AT Traffic Devices Manager, when the proposal for trialling a new type of crossing on Massey Road was sent to the NZTA's 'Traffic Control Devices Steering Group', on which he also sits, the committee '*just didn't like it, didn't see the need for it*'. The justification for this decision was based on the logic of consistency:

> *So, that was sort of seen as not a safe proposal because unless it was going to be applied to all pedestrian crossings you're not gonna have consistency and one of the main things about what makes a good traffic control device is that it's applied consistently so that people become familiar with it and … respond to it instinctively without it being analysed so much and this [proposed TCD] would have created … a two-tier system for pedestrian crossing.*

It would seem that with there being an existing TCD considered as already fulfilling the role of the proposed Massey Road crossings, there was a resistance within the NZTA's TCD steering group to trialling a new device that diverged from that design. Instead, consistency was encouraged as it is seen as less problematic and more predictable – with change and greater inconsistency therefore cast as inherently riskier. As such, through this logic, innovation, which necessarily involves change to existing practices, is likely to be construed as problematic, potentially risky, and attract significant scrutiny.

For the Future Streets project team, consistency was also seen as an important part of creating a safe environment with a high level of amenity. However, it was consistency of design *within* the local neighbourhood that the project members deemed most critical. This design goal was driven by the benefits of implementing so-called '*self-explaining roads*' (SER) at a neighbourhood scale, as previously demonstrated in Auckland through the Point England regeneration project (Mackie *et al.*, 2013). Several of the research team had worked on this project and were confident that Future Streets could provide a similar success. As one member of the research team commented:

> *I think we certainly all had the idea that we did need to have a level of design consistency to achieve a sort of a self-explaining road type concept … homogeneity is very important for trying to set up the expectations for drivers on how to behave.*

Thus, the goal of creating SER is to consistently employ visually distinct road designs in order to evoke the correct expectations and driving behaviours from road users (Charlton *et al.*, 2010). SER road designs are ordered in a hierarchy reflecting their function: e.g., access roads, collector roads and arterial roads. Consistency is therefore important within each category of road, so that they afford the desired driver expectations and behaviour.

The project team were therefore sympathetic towards the goal of consistency. However, there was perhaps a discrepancy between the project team and the TCD decision-makers within AT and NZTA regarding the purpose of consistency. For the project team, consistency was important to establish a clear road hierarchy within the local area. However, for decision-makers within AT and NZTA charged with assessing TCDs, the logic of consistency encourages a harmonisation and limiting of the types of devices installed across regional and national networks.

National and international

Equally, the NZTA also seeks a level of performance consistency across the national network. An interviewee suggested that the agency favours traffic solutions that can be adopted nationwide:

> *[The] NZTA often won't allow something to go ahead unless they see the benefit for the rest of the region … it does mean that you can't just suddenly radically go through a new style of pedestrian crossing … because it is unlikely that another local authority could afford to roll those out, so you wouldn't be able to tell what is the benefit to the rest of the country.*

As a Principal Advisor for financial investment, the participating NZTA Traffic Engineer was familiar with this type of assessment. His statements supports the claim that national consistency is a key logic in transport decision-making:

> *We try to normalise things so that the drivers don't get confused, and our organisation as well, because we are responsible for them.*

Here, the Traffic Engineer further indicates the positioning of consistency for road users within an organisational consistency. He later expanded on this point, asserting:

New Zealand is part of Austroads and so, singularly, you apply Austroads guides unless we have a NZ standard that is recognised. They are still guidelines, but it is a brave man to choose to do something that is not [within them] …

While there would seem to be some room for flexibility around these '*guidelines*', clearly there needs to be an acceptable justification for operating outside of them. The threat of going outside the guidelines is the risk of exposing the organisation or an individual to legal ramifications, and/or personal blame for unintended or unexpected and potentially undesirable consequences. As the AT Traffic Engineer explains, the people who sign-off on new devices within AT and the NZTA are inclined to be '*conservative because their names are on the resolutions, so they are liable … so if they don't like what they see they will stop it from happening effectively*'. As discussed below, avoiding exposure to legal remonstration is a powerful logic within transport planning. Thus, actions that are deemed to take the organisation and individual outside of standard practice (as indicated in the guidelines) become understood as inherently risky behaviours.

Such concerns are suggested to have impacted upon decision-making regarding the Future Streets project and the Massey Road crossings. As indicated below, the justification and impetus of 'innovation' within the project is positioned by the NZTA Traffic Engineer against the risk that the new designs might increase the public's exposure to harm:

… I guess with Future Streets … they were real keen on innovation, so someone has to make that call that we are going to take the risk that you might actually kill more people by doing it this way or you just won't get the results you want and you will totally waste your money. So you have to balance that up. Do you stick with the tried and true?

Contrasting the opportunities for innovation with the potential for exposure to legal prosecution is a framing that is likely to compel attachment to existing designs. Adherence to existing solutions offers considerable protection from the legal consequences of any accidents that might occur. Conversely, the decision to introduce a novel solution is liable to attract significant attention should an accident occur on that section of road. Thus, the logic of institutional consistency is built upon an emphasis on predictability and calculability, and the pressure of financial and legal accountability.

For the NZTA to justify the trialling of a new device there is an expectation that it has viable applicability across New Zealand. Indeed, as indicated in the earlier quote, beyond national consistency, there is also an impetus for standardisation with Australia. Opportunities for '*harmonisation*' are primarily facilitated through the NZTA's membership of Austroads, as the NZTA Traffic Devices Manager explained:

… we try and ensure that we are continually striving for international consistency, particularly harmonisation with Australia. We are a member of Austroads and we commit to harmonisation across Australasia. So again, I am not looking for devices that move us away from consistency with Australia.

Austroads positions itself as the '*peak organisation of Australasian road transport and traffic agencies*'. 'Peak organisation' is a specific Australian term for an advocacy group or trade association that lobbies government and promotes the interests of an industry sector. According to their website, Austroads provides '*a collective approach that delivers value for money, encourages shared knowledge and drives consistency for road users*'. The organisation publishes and shares road-related research and reports across its members. The NZTA Traffic Devices Manager stated that when seeking advice on roading issues, he consults primarily with the NZTA's own steering group and Austroads: '*A lot of those guys in the Australasian jurisdiction sometimes have come across the same type of issue and then I can test ideas with them*'. The statements of both participating NZTA employees indicate that Austroads is an entity with a potentially significant influence on the defining of design standards that direct New Zealand road transport decision-makers.

It is not surprising, then, that the organisation is also identified as influential within AT's transport planning decision-making. The AT Traffic Engineer identifies them as '*basically our go-to guidelines for road design*'. However, he is critical of Austroads adherence to a 'link road theory' model in framing traffic problems and solutions. As discussed earlier, this model is something which he argues has been a central logic to traffic engineering since the 1960s. According to this participant, this model has continued to be influential within transport planning in Australia and New Zealand, and has led to the design of road environments based on '*geometirics*' and '*formulas*'. The road environments that result from this philosophy encourage the high-speed movement of cars based on the premise that road user behaviour can be predicted and calculated. The AT Traffic Engineer suggests '*engineering conservatism*' as a reason for this design philosophy's apparent obduracy within transport planning when seeking solutions to transport problems. Consequently, he states, '*the frustration [is] that this just links you to a pre-defined palette … [and] our traffic engineering colleagues … are really reluctant to do something about it. And it causes problems'*. Thus, adherence to consistency, regionally, nationally, and internationally with Austroads, embeds existing solutions related to the incumbent design philosophy within New Zealand at multiple levels of decision-making.

Consistency and asset management

As indicated at the beginning of this section, consistency is valued by transport planners, not only as a characteristic of the road environment, but also within transport planning processes. The demand for consistency is embedded at multiple levels throughout the transport planning decision-making network. Consistency allows transport planners and traffic engineers to work together on and across projects with a level of certainty and predictability. AT must deliver on a large number of projects across the Auckland region, while maintaining the performance of the existing road network – all within a tightly restrained and highly scrutinised fiscal environment.

Budgeting to regularly maintain a network under these conditions can be strengthened through ensuring a high level of predictability and calculability in asset management. In order to effectively utilise the region's transport budget, the labour and materials required for the maintenance of each asset must be accurately planned. Equally, the additional maintenance costs of newly installed assets, such as TCDs, must be predictable. As the AT Traffic Engineer explained, close adherence to a set of network-wide design standards goes towards supporting such goals:

> *… without standards we get inconsistent design and asset design, so it costs more money to maintain. [AT] set standards around material finishes, pavements, footpaths, structures to make sure that … we are pushing each asset into an envelope whereby it is not over burdening a yearly budget.*

In order to accurately plan asset management, the design standards are proscribed to a precise technical level. An example of the level of measurement required to ensure consistency is provided by the AT Traffic Engineer:

> *Consistency from an asset materiality. So when we say 25 MPa concrete, its 25 MPa everywhere – that has no consequence, it has no maintenance aspect to it. We know if you take a diamond saw cutter, it will take such time to cut through it so the costs associated with fuel and labour.*

These detailed design standards, to be adhered to in all AT projects, are designed to ensure consistency in the usability, durability and longevity of every asset across the network. Since transport projects invariably involve multiple stakeholders, both across AT departments and numerous external contractors, these standards form a network of sociotechnical expectations and understandings. Being able to reliably depend on the mutuality of this relationship can help to ensure consistency in the planning of asset management.

Introducing a new type of pedestrian crossing outside of the standard is therefore also introducing a new asset requiring consideration for installation, maintenance and renewal budgeting. The introduction of a new TCD could also act to destabilise the existing sociotechnical network tied to specific existing TCD solutions. While the proposed crossings on Massey Road would have had many requirements consistent with existing designs, their framing as a divergence from existing solutions by high-level decision-makers may have served to indicate to stakeholders involved in assessing the devices that they could be a potentially costly outlier on the region's road network.

The logic of consistency builds upon a desire for calculability and predictability in the road environment, traffic control devices and even the roads users themselves. Inconsistent design is something which traffic engineers state they wish to avoid, so as to not confuse road users and potentially cause a loss of situational awareness. An exception is when confusion is considered a desirable tool to make drivers cautious, and is actively stimulated through TCD designs. Beyond the premise that road environments should not be *overly* confusing for road users, consistency is equally related to a need for financial and legal accountability – all of which compels a path dependency towards constructing and maintaining a high level of uniformity on the road network.

Collective agreement and shared ownership

Another decision-making factor related to the logic of consistency is that of shared ownership. 'Buy in' is both a *de jure* legal and organisational requirement, and a *de facto* everyday decision-making logic. The theme of shared ownership and collective agreement was commonly discussed in the interviews as an important aspect of good transport decision-making at both regional and national levels. With particular regard to TCDs, AT's internal 'traffic resolution' procedure requires a sign-off from relevant departments before reaching committee approval level. Similarly, within the NZTA, 'sector buy in' and collaboration between regional authorities was highlighted as a significant consideration when approving the trial of a new TCD. However, within a risk averse industry such as transport, the logic of collective agreement can also engender the sociotechnical obduracy of existing solutions and stifle innovation. The 'ownership' of particular design solutions within sociotechnical networks can 'lock-in' decision-making practices, leading to path dependent trajectories.

AT: Legal imperatives in collective agreement and the politics of 'sign-off'

When making changes to AT's road network, including restrictions, physical devices and controls, a specific internal 'traffic resolution' procedure is required in order to satisfy the Traffic Control Committee that all relevant parties have been consulted and the proposal is justified. As part of a much larger politico-legal framework, this procedure is designed to ensure AT's traffic resolutions are '*legally robust*'. Auckland Transport was established as the Road Controlling Authority (RCA) for Auckland's transport system under the Local Government (Auckland Council) Act 2009, which provides it with authority to operate through the 'Roads' sections of the Local Government Act 1974. This Act allows AT to create bylaws. These bylaws establish AT's authority to create resolutions that implement specific traffic restrictions and controls in designated locations. This authority to make resolutions is delegated by AT to the Traffic Control Committee (TCC) (Auckland Transport, 2015). As described by the AT Traffic Devices Manager, who is involved in managing the legal approval process for traffic controls, the TCC legalises the resolution but must be satisfied that every relevant department has been consulted and agrees with the resolution before making their decision:

> *… those controls have to be made by resolution and the legal interpretation on resolution is a decision by a body, so it can't be delegated down to an individual officer. It's got to be a joint decision made by a group entity … so, that's our committee … what I'm saying is the committee and the manager are making the formal legal decision but they take comfort and advice from their officials who advise them this is an appropriate decision to make.*

The traffic resolutions procedure therefore puts an emphasis on a joint decision made by committee through the advice of relevant officials – primarily so that the legal risk is shared by a group rather than any particular individual decision-maker. Thus, significant emphasis is placed on a mutual agreement across each of the relevant departments.

As the proposal is assessed by each official, the AT Traffic Devices Manager acknowledged there are situations where this system can cause delays:

> *You know if it's something small, they've just got to say, "I think that there's a problem with this and it needs to go back". And that bit gets worked on a little bit more and then it will come forward again. Very occasionally you'll get a situation where one of the sign off people will say, "Our department disagrees with this proposal. All the other departments do agree". And, it becomes an impasse and so then that might go to the*

committee without everyone agreeing to it here and the committee then has to … decide on the impasse, but we try very hard to avoid that.

In situations where amendments are suggested by an official, the delays are usually expected to be only minor while revisions are made. In this situation, it is suggested that the process should take around two weeks. However, there can be times when a particular official or department strongly disagrees with a proposal. On these occasions, there can be an '*impasse*' where a particular proposal is accepted by almost all departments, but is nevertheless held back by disagreement from an implacable non-consenting party.

After being initially rejected for trial by the NZTA's TCD steering group, the new design solution presented for the Massey Road crossings was taken back for consultation with AT departments. The research team indicated they had '*socialised*' the new idea with TCC members, but it had not '*officially*' gone through the TCC procedure. It is possible members of departments within AT felt aggrieved at not being consulted before the proposal for the crossings was sent to the NZTA's steering group. As the research team member stated:

… there was a bit of a problem in that I think some of the AT people felt like they hadn't been engaged with properly. Perhaps if we had some of the conversations with some of those people earlier in the process, we might have got a slightly better reception. But it's very hard … we had this big workshop at the front, all of these people were invited to it, some of them didn't come and so there was a missed opportunity right at the start … it's quite tough just literally trying to connect with all the people that you are meant to.

The problem of miscommunication across the development partners was noted by all parties involved with the Future Streets project. The NZTA Traffic Devices Manager argued that members of the research team should have been '*fully familiar*' with the trials process from previous experience. However, there was an apparent lack of clarity for the research team in the relationship between the trialling and legalising decision-making process for the NZTA's TCD steering group, and decisions made by AT's TCC. As the AT Traffic Devices Manager acknowledged:

Now, we don't do so many trials that there's … a clearly established process … we only do one or two trials a year that we're involved in and … consultants or other teams might never be involved in a trial. So, you know, it's not so well-known that it's outrageous that they got there [the proposal to the NZTA's TCD steering group] without coming through us … but, to call it a process might be slightly overstated as well.

The lack of a clear TCD trialling path, described by a research team member as '*slack in the system*', can create a level of operational flexibility and autonomy in what RCAs are able to construct on their particular road network. However, it would seem in the case of the Massey Road crossings that this uncertainty also led to significant misunderstandings between various stakeholders involved in the project regarding the due process required to propose and legalise a TCD trail. The breakdown in these partly *de facto* legal and organisational decision-making processes resulted in delays in the consultation and final sign-off of the project within the AT administrative structure.

As mentioned above, the miscommunication between the project team and departments within AT potentially diminished feelings of '*goodwill*' towards the project. This sentiment may have had further implications when '*sign-offs*' were eventually sought from relevant departments within AT for the Massey Road crossings. During the intervention, the Project Manager (delivery) was a key link between the Future Streets project and the broader administrative structure of AT. He pinpointed how the project encountered a significant impediment while seeking consensus during the traffic resolution process for the new crossings:

> *… for those crossings you need a traffic resolution and that requires a number of sign-offs from various parties. One of those, which is part of the consultation exercise, we did hit a block with Intelligent Traffic Solutions, I think they call themselves. They said that they would object to our proposals.*

The prospect of an objection during the TCC's 'traffic resolution' approval process meant the likelihood that an impasse would occur during the search for mutual agreement. A significant delay therefore became a likely possibility. As the Project Manager (delivery) explains, such an eventuality was a significant threat to the viability of building the new crossings:

> *[It] would have just made everything very difficult … because you really do need to get everybody on board and supportive. If you have somebody there who is blocking it or objecting to it, then it becomes a very difficult task … if you have something that … has not been resolved, it basically could fall over at that end.*

The standard time for a traffic resolution to pass through the sign-off process was stated as around two months. However, this delay in gaining approval for the new crossing type held back construction of any new crossing devices on Massey Road for 18 months – jeopardising the research goals of the project and obstructing the provision of anticipated road safety features for the local community.

The pressure to achieve a solution that is jointly 'owned' and agreed upon can potentially have a significant impact on consenting of new TCDs. The path dependency that essentially necessitates a full agreement from all departments before approval '*sign-off*' by the TCC can occur is built upon both *de jure* technical requirements and *de facto* social expectations within the transport planning assemblage. These factors allow for political leverage to be enacted during the resolution process. Departments and officials that are committed to a particular solution are potentially able to leverage their support for changes to the design. As identified by several interviewees from the Future Streets project team, the commitment of Intelligent Transport Systems (ITS) within AT to an existing TCD solution led to an impasse during the resolutions process for the proposed Massey Road crossings. This impasse caused significant delays to the provision of crossings for the Māngere community on Massey Road, and ultimately led to the abandoning of the proposed trial of a new type of crossing and their substitution for existing TCD solutions (that were already contained within the design manual).

ITS are consulted as part of traffic engineering in the traffic resolution process, and are involved with the technological aspects of TCDs, including: electronic signs, lights, cameras and sensors. Thus, changes to the design of pedestrian crossings, which combine multiple technological devices, are likely to have particular pertinence to them. The proposed crossing type for Massey Road would diverge from the existing solution in the technologies used – although both build upon a standard zebra crossing design. The designs for both the proposed crossing for Massey Road and the existing solution are presented in Appendix A and B. The proposed 'enhanced zebra' crossing for Massey Road would have included a number of technological devices connected to work together: pedestrian activation buttons on either side of the crossing connected to flashing lights; a 'light bar' which would attach to new or existing signage poles and flash when activated by a pedestrian; and potentially, a solar charging panel. The existing solution, known as an 'in-pavement flashing light warning system', is not pedestrian activated, but uses detection devices to automatically activate should it sense the presence of a pedestrian. The sensor device can either be photoelectric light sensitive, to detect movement in a calibrated 'pedestrian threshold', or a pressure sensitive pad embedded in the pavement at the side of the crossing. The detection devices are linked via 'armoured power cable' to a controller unit that, upon sensing the presence of a pedestrian, sends out a signal to the linked 'in-pavement flashing warning light studs'. These studs contain a flashing light emitting diode (LED) within a protective casing, transparent on the upwards facing side, and are embedded within the road surface. Current examples of this crossing type use around 16–18 of these studs, running along the centre line of the road for up to 40 metres either side and horizontally along either side of the crossing zone, in order to alert motor vehicle traffic to the presence of a pedestrian wishing to cross.

The differences between the proposed and existing solutions led to a certain level of '*negotiation*', both within the project team and subsequently between the project team and other AT departments during the TCC process. The research team member recalled the difficulties that arose due to the commitment within AT to existing solutions:

> *So, there was a little bit of negotiation between us about what the final result should've been for those designs but we got there, you know after a reasonable kind of a design negotiation and then we sort of said, "Right, okay we all agree that this is something that we could test." Then when we put it back to the TCC Committee … and not just the TCC Committee, but also the people within AT who actually look after ITS Solutions, … there was a bit of resistance about this particular solution, again because [there was] this existing solution that there was a certain degree of ownership of.*

The researcher suggests there had developed a level of '*ownership*' to the existing crossing type within AT, and perhaps particularly within ITS. Arguably 'ownership' in this sense suggests that particular institutional networks had embedded the existing TCD within AT's sociotechnical systems. Existing solutions are therefore harnessed through a network of technological and social connections between engineers, planners and their suppliers, through integrated shared logics and practices. Consequently, the existing TCD has generated a sociotechnical obduracy that has proved resistant to potential sources of change, and through an adaptivity has worked to stabilise this network through a reassertion of designs that utilise existing solutions.

As suggested by the Project Manager (delivery), this resistance materialised in attempts by ITS to influence the design of the crossings by leveraging their support for the project during the 'traffic resolution' process:

Project Manager: Well it was going to get rejected within AT, never mind NZTA, so we had a problem there – and I thought this was a little bit naughty – but basically they *said we have some proposals and if you let us implement those, we would be happy to do that as part of the crossing.*

Interviewer: Sorry, just see if I have understood this. So ITS looked at what you were suggesting and said we have some other alternative that we would like to trial. If you trial this one, we will support your proposal?

Project Manager: Yes … and they could object to it along the route and so the whole idea behind the traffic resolution is meant to be a legal exercise, creates a legal bylaw. But what actually happens or can happen … is that it turns into another detailed design review and you are going over it again … So, if somebody in road safety is not happy with something, they will go "I am not happy with that and you need to do this otherwise I am not going to sign it" … So this process is a little bit flawed.

During this period of negotiation, it is suggested the ownership of the existing solution by members of ITS led them to challenge the proposal of a new form of crossing, eventually leading to the construction on Massey Road of a reiteration of the existing TCD solutions. According to the Project Manager (delivery), he '*took a Project Manager's view of it*' and made the pragmatic decision to adopt existing designs to guarantee some form of crossing would be provided to the community from the project.

The logic of collective agreement in transport planning decision-making is aimed at providing a legally defensible foundation to any change to the road network, as well as reducing the risk of personal liability and the potential for litigation against individual decision-makers. However, an implication of prioritising the search for collective agreement is that it supports institutional inertia – an embedding of sociotechnical systems and a forming of 'persistent traditions' – that can stifle innovation.

NZTA: 'Consensus building' and 'sector buy-in'

Shared ownership and collective agreement through 'consensus building' is also a decision-making strategy at the national level. Collective agreement is a logic within both formal and informal decision-making practices within the NZTA. Collective agreement is formally sought through the 'Traffic Control Devices Steering Group', which acts as an advisory committee to facilitate discussion amongst transport industry representatives from both the public and private sector with the NZTA's Network Manager. Informally, and related to the logic of consistency, approval was seen as more likely if TCDs were to be trialled across several RCAs compared to those seen as site-specific and inconsistent with the broader network.

Both the interviewed AT and NZTA Traffic Devices Managers are key decision makers for the trialling of new TCDs. However, within the NZTA, one manager has the designated authority to solely evaluate and make judgments on whether to approve the trial of a TCD on the national road network. However, in order to advise them on the acceptability and level of '*enthusiasm*' for a proposed TCD within the transport sector, the manager refers trials for scrutiny to representatives from the sector before making his decision. A key goal of the group is to generate '*buy-in*' across the section to particular TCD solutions. As described by the NZTA Traffic Devices Manager:

[T]o help … with that decision making … for a number of years now … [we have] a traffic control devices steering group, which is a group of representatives from across the sector … and they help [to] decide whether a trial actually should go ahead.

The board convenes quarterly as the 'Traffic Control Devices Steering Group', and includes representatives from the transport sector, such as: the NZTA, Ministry of Transport, local RCAs, the NZ Automobile Association, roading contractors, and the traffic sign and road marking industry (NZTA, 2011). According to the NZTA Traffic Devices Manager, the steering group is used as a '*litmus test*', but also as an opportunity to encourage collaboration:

[S]ometimes [RCAs] come up with what they think is a bright idea to fix a problem that they think exists … and if the consensus is that there are other ways of dealing with it and they are not doing this or that right or whatever … [then on] the strength of that steering group … feedback … [we] may decide to not approve a trial … We have to try to take the whole sector through with us so that the end result is owned.

As stated in the above quotation, a key purpose of seeking collaboration and collective agreement is to ensure '*the end result is owned*' by the whole sector. Seeking shared ownership of decision-making outcomes would seem to be an important logic within transport planning. Nevertheless, this process within the NZTA seems to remain somewhat informal, since the decision-making authority to approve trials remains solely with the Network Manager. The steering group holds no statutory powers and only acts to advise the NZTA.

Further evidence of the logic of shared ownership and collaboration as an important justification within transport planning decision-making arose in the interview with the NZTA Traffic Devices Manager. When considering a proposal for a new TCD trial, the potential for collaboration across multiple RCAs and test sites is argued as strengthening the evidence base and final case for its approval. The steering group is seen to provide a shared social space for this form of collaboration across RCAs to be generated. As stated by the NZTA Traffic Devices Manager, the steering group:

I might have one Road Controlling Authority come up with a good idea for fixing a problem and we will find other Road Controlling Authorities say, yeah, we wouldn't mind doing that as well. So then we would get a trial of five different Road Controlling Authorities around the country which is far more robust as far as the end game or result is concerned instead of having just one or two.

The '*end game*' in this case would seem to be increasing consistency of devices and approaches used across the national road network. In this case, proposals that are jointly supported by several RCAs are potentially more likely to gain acceptance from the NZTA.

It is worth noting that the existing active warning light pedestrian crossing design described earlier in this section, and favoured by the NZTA over the 'enhanced' zebra crossing proposed for Massey Road, was submitted for approval jointly by both the Christchurch and Auckland City Councils in 2005. Two trial sites in Christchurch and one in Auckland were chosen, with a number of technological and layout design elements varying between them. Given that it was jointly submitted by two RCAs and involved three trial sites, this proposal would therefore seem to fit better within a framing of shared ownership and collective agreement than the Future Streets proposal, which, as a single-site proposal, became framed by key decision-makers as '*inconsistent*' with the wider national network.

The logic of shared ownership through collaboration offers the potential to transmit the rationale for new design solutions and build support for innovation. However, reaching shared ownership of a solution can also act to solidify the obduracy of the status quo. Ownership of a particular solution creates a form of institutional inertia or obduracy that can be difficult to overcome. Furthermore, the necessity of sign-offs can enable particular individuals or departments to wield a disproportionate level of influence over the approval process in order to gain leverage for revisions. Such influences are likely to tend towards a reassertion of existing solutions to transport problems. The obduracy of these solutions is maintained through their embedding within an existing network of social and technical relationships. Transport decision-making is a product of the interconnected heterogeneous relationships between the various bodies (human, corporate and state) involved in transport planning and construction, shared knowledge, discourses and tools, as well as the broader environments in which decision-making takes place (physical, legal and social, amongst others).

Risk: Safety, legality and avoidance of risk

Risk is a logic with overt significance, but also underlying importance within contemporary transport planning. Identifying, managing and avoiding risk are key concerns for transport planning decision-makers. However, aversion to risk can compel an inherent conservatism and is therefore arguably a strong factor in limiting opportunities for innovation within the transport sector. An important factor in transport planning decision-making is how particular framings of risk become embedded within an institutional culture.

As a particular logic within the transport sector, avoidance of risk is ingrained within practices and systems. The ingrained risk-averse nature of transport planning is identified by the AT Traffic Devices Manager, and portrayed as an appropriate stance for the sector and not problematic:

> *I think it's probably so fundamental, it's not from anywhere. I think it's just accepted as, yeah, I can't think of any sort of written policy to that effect. It just goes without saying … and I don't see that as a frustration, I see that as a positive and … appropriate for safety.*

It is difficult to argue that a commitment to safety is not an appropriate stance for transport planners and traffic engineers to maintain. However, in order to understand the impact of risk-related logics on transport decision-making, it is crucial to understand how definitions of 'risk' are generated, and the processes that can lead to a decision being defined as either 'risky' or 'safe'.

A number of different forms of risk were identified in the interviews, often related to the position held by the interviewee within the transport planning assemblage. The primary concern was risk to public safety, however risks to organisational reputation, legal risks and financial risks were also important considerations, both in their own right and as a consequence of public safety issues.

The priority of public safety and reputation

Public safety was frequently stated as the primary concern in transport decision-making. The interviewees were keenly aware that the decisions they make, in terms of road design and selection of TCDs, have a direct consequence on the potential for acute physical harm to road users. When asked to consider what the most important values of his organisation were, the AT Traffic Devices Manager stated:

> *Safety always trumps others. But, you know one person's interpretation of safety can be different to another person. But, yeah … I can't think of anything that would ever trump safety.*

Protecting the public from risk of physical harm from traffic accidents is a particular concern when considering new designs. As the NZTA Traffic Engineer mentioned previously with regard to allowing for innovation: '*…someone has to make the call that we are going to take the risk that you might actually injure more people by doing it this way*'. Equally, as the AT Traffic Engineer stated with regard to trialling new TCDs: '*We will evaluate it and do everything we can with due care to mitigate every foreseen risk that we can see that is going to cause a death or serious injury*'. These comments suggest the weight and high level of concern transport planners and traffic engineers place on reducing the risk of injuries and fatalities on roads.

However, it must be expected that accidents will happen, and are, to some extent, an unavoidable consequence of environments in which heavy objects such as motor vehicles operate at high speeds in close proximity to human bodies. As discussed at the beginning of this paper, such an understanding is reflected in the growing recognition of 'Vision Zero' policies around the world. These policies can be characterised by their emphasis on the vulnerability of the human body, and the need to design road environments that reduce vehicle speeds and encourage driver alertness in order to minimise the harm caused in traffic accidents, particularly to pedestrians. The movement towards such a philosophy in transport planning has had significant bearing on the particular objectives that transport policy and decision making seek to prioritise and address.

Reducing vehicle speeds along residential roads to a level where significant injury or fatality is unlikely to occur in the event of an accident would, on the one hand, seem like the most obvious strategy in order to prioritise public safety. On the other hand, transport planners must also consider the efficiency of the road network and respond to pressures to reduce travel times and congestion. The significant tension within transport planning decision-making between safety and efficiency was expressed by an AT Traffic Engineer:

> *You can make things safe [when] the speed is dropped and the severity of the crash reduces … But from a productivity perspective, we don't like to drop the speed limits. So [with] Massey Road, which is a 60km speed limit, high volume, where dropping the speeds would be beneficial for the people that move across, especially the kids – and we won't do it because the corridor is considered to be more important … than surrounding land use.*

From this statement, we can see how balancing the goals of public safety and traffic efficiency can be problematic for transport planners. It is arguable that in the case of Massey Road, the efficiency of traffic through flow has historically been prioritised, as the 60km/h speed limit along this road is 10km/h higher than the standard for residential roads. Thus, while reducing the risk of serious injury and fatality on the road network is a central objective for the NZTA and AT, both organisations must also meet objectives concerning network efficiency – failing to meet these objectives also presents risks, particularly to the reputation of decision-makers.

This leads to an additional consideration, in that the risk to organisations such as AT and the NZTA from traffic accidents is not directly due to the physical harm such collisions cause – since an organisation cannot be physically harmed in such a way. Arguably, then, as important as public safety is to these organisations, it is essentially the secondary risks of accidents that directly impact upon them. In this case, decision-making that is interpreted as having increased public risk is of concern because it presents a reputational risk to transport organisations, who may consequently be deemed as ineffective or incompetent. Closely related to reputational damage are legal risks, as indicated in the statement below from the AT Project Manager (delivery):

> *Once we start to change things then designers and the authority do get very concerned and very conservative … because of the reputational and legal risks associated … Quite how real they are I don't know, I have never sat down and looked at it but, yes, as an organisation we are very risk averse to reputation and legal risk.*

It is important to note that the reputational and legal risks mentioned are not limited to the organisation. Individual employees can potentially be held to account for the consequences of their decisions, both internally and externally through public opinion and legal prosecution.

The demands of working through the AT standard operating procedures, while also attempting to engage with and incorporate the potential for innovation offered by the Future Streets project, caused a considerable amount of stress for the traffic engineers involved. As recounted by the research team member, in one particularly difficult meeting between the research team and the AT delivery team for the project, one manager exclaimed:

> *"I could lose my job over this" and you could see this sort of frustration and worry just kind of spilling over … because he was being … asked to sort of think outside of the normal design parameters and processes that AT would normally go through … So he was just saying really that put him in a position of risk to be going outside of the normal rules and things.*

Within AT's structure ,the investigation and design phase involves a separate team from the subsequent construction delivery team. The AT Project Manager (design) was involved with the Future Streets project in the investigation and design phase, and during the stalled traffic resolution process for the Massey Road crossings. He reiterated the influence of individual risk on decision-making when encountering new designs:

> *… the other big problem when you do stuff 'outside the box', which is not the standard, a lot of people are worried about the risk to their position, because they don't have the delegation to approve that. So they might think it's good … but because it's not part of their code of practice, or the things they've been doing for all the 20 previous*

years … they don't have the courage to be on-board with it, so [they] just try to avoid making decisions, which is what happens.

His statement suggests that there is a feeling of inherent risk when considering the adoption of new practices or designs within a transport proposal. Irrespective of whether they agree with the proposed ideas, adopting non-standard solutions is likely to be avoided by individuals in order to prevent isolating themselves from standard institutional structures and practices, and potentially exposing themselves to individual-level legal and reputational risks.

For the traffic engineers working on such projects, operating within institutional guidelines and expectations provides a certain amount of individual legal and reputational protection. As illuminated further by the AT Project Manager (delivery):

[T]here is very little authority or delegation at the lower levels … As long as I am within scope, I can make decisions … but as soon as it requires a little bit beyond scope, then I have to get the approvals … So once we start to change things then designers and the authority do get very concerned and very conservative.

Essentially, through an institutionally structured and fixed decision-making hierarchy, each engineer has only a limited space for decision-making as determined by their position and role within that hierarchy. However, operating outside of this hierarchical risk management structure threatens to expose an individual to scrutiny and potential legal prosecution. Thus, unless innovative practices are given clear endorsement by a higher-level organisational authority, attempting to operate in non-standard ways places a significant amount of risk on the shoulders of individual project-level decision-makers.

Risk-avoidance leading to conservatism

As indicated in the above statements from both AT project managers, in order to avoid exposure to legal and reputational risks there exists an institutionally embedded practice or path dependency towards the sociotechnical obduracy of existing designs; that is, an inherent conservatism in order to avoid exposure to risk from the uncertainties of innovation outcomes, and a preference for technologies and practices that are already socially and technically entrenched within the transport planning assemblage. Transport decision-makers deem these existing solutions as safer or less risky because modelling their outcomes is expected to be more calculable and predictable.

This culture of conservatism can be seen as part of an institutional inertia and a path dependency towards particular solutions. During the proposal process for a new crossing type for Massey Road, the path dependency within the New Zealand transport assemblage towards existing devices led to the proposal being framed as unnecessary, inconsistent and potentially risky. The AT Traffic Engineer discussed his frustrations in encountering this conservatism towards the proposed Massey Road crossings while working as project manager for Future Streets:

[We wanted] to create a dynamic different environment where people go: oh, not only can I cross where I actually want to cross, but I am now given the priority – and people

can see what this is trying to intend. But the conservative nature of how traffic engineering is developed often restricts that and … just links you to a pre-defined palette of [devices] and ... [so] we can't put the crossing in because the person who's driving may not expect it.

His statement indicates that traffic devices are not just technical apparatus, but are imbued with particular transport planning philosophies that can align or conflict with dominant framings of traffic solutions. He suggests that because the proposed Massey Road crossings were a novel approach intended to prioritise pedestrian movement over vehicular movement, this generated uncertainty for traffic engineers over the actions of drivers who might encounter this crossing type. Arguably, the powerful logics of consistency and predictability can cause an impedance to the adoption of novel ideas within transport planning, as they are associated with increased risk.

Risk-avoidance practices may cause transport authorities to be particularly sensitive to proposals to trial new pedestrian crossing devices. Consequently, such a proposal could be more likely than trials of other devices to attract the types of risk-averse decision-making discussed above. The NZTA Traffic Devices Manager made his opinion on the seriousness of pedestrian crossings clear in his response to whether a flashing LED crossing type would be allowed on a 60km/h road:

No, I wouldn't have thought so, no. Pedestrian crossings are dangerous things – dangerous, dangerous, dangerous.

Under Land Transport Rule Traffic Note 28, the type of crossing allowed and the level of oversight required varies significantly between roads that are considered an 'arterial' (major urban road) and have a speed limit of greater than 50km/h, and those that have a speed limit of 50km/h or less. This legislation has particular pertinence for Massey Road, as it is a residential road that currently has a speed limit of 60km/h. As the NZTA Traffic Devices Manager explained:

We found out that the speed limit on that particular road was 60km/h. So the question then was, under the rule, if a pedestrian crossing is installed where the speed limit is greater than 50km/h … it needs the agency's approval. Because pedestrian crossings are unsafe at the best times, let alone in higher speed environments and that is why that requirement was put in the rule.

This structuring of the level of oversight required for different speed limits further indicates the broader governance of risk within the transport sector. This statement also reinforces the NZTA Traffic Devices Manager's concern towards the apparent danger of pedestrian crossings.

Data from the Ministry of Transport (2017) supports the notion that pedestrians are particularly at risk while crossing roads. Their analysis of police-reported crashes during 2016 found that 84% of pedestrian casualties reported on urban roads occurred while the pedestrian involved was crossing a road. However, 64% of these casualties occurred while the pedestrian was crossing the road at an uncontrolled site – for example, not at a pedestrian crossing or traffic light. Meanwhile, around 10% of pedestrian casualties occurred on a signalised crossing, and a further 10% occurred at or near a zebra crossing. This data suggests that while controlled crossings are the site of around 20% of pedestrian causalities, the majority of collisions between vehicles and people happen while the individual is not using a designated pedestrian crossing site. It is arguable that, although pedestrian crossings are a potential site for serious injury or fatality to pedestrians from road traffic collisions, they offer a considerably lower risk than when a pedestrian crosses without using a form of controlled crossing.

Thus, it is important to consider that while transport decision-making must take into account the associated risks of each device placed on the road network, there is also a risk in doing nothing, or not doing enough or better. An overarching objective of the Future Streets project was to attempt to improve how local transport planning was conceptualised and put into practice at a neighbourhood scale. Trialling a new crossing type that would be cheaper and easier to install and give a clearer priority to pedestrians was a key aspect of the proposal. A strong motivation for trialling new crossings on Massey Road was the current issues the local community had raised during the consultation with crossing the 60km/h road, particularly for their children. As the research team member recounted:

> *So … the risk of leaving Massey Road as it is, for example – even though we know children have been seriously hurt and killed on it – [it] doesn't seem to be as well appreciated as the risk of actually getting up there and putting something on there.*

A prevailing culture of risk-avoidance within transport decision-making is rationalised through the need to reduce exposure to litigation and reputational damage from decisions that are seen to have negative outcomes. However, the path dependencies that develop through associated logics of consistency and predictability do not necessarily align with the needs of local communities. The risks that communities are exposed to in their local road environment are direct physical harm, and the subsequent social costs associated with the serious injury or death of family members, neighbours or other members of the community. Organisational structures and practices that limit individual exposure to legal and reputational risk, primarily through limiting decision-making responsibilities of individual managers and engineers, also limit the space for innovation and responsive adaptation at the neighbourhood scale.

6 Space for Innovation

This paper has used the proposal to install a novel type of pedestrian crossing, as part of a neighbourhood intervention, as a case study to investigate the architecture of decision-making that influences the delivery and outcomes of our urban environments. Te Ara Mua Future Streets intervention in Māngere specifically aimed to innovate and test new ideas to solve long-term transport problems. A key aspect of the intervention was its neighbourhood-scale design, which promoted the connection of design solutions across the project area to provide a local environment more supportive of active transport options. However, working at a neighbourhood scale has proven challenging for the project team, and brought them into conflict with the shared logics and standard processes and practices of stakeholder organisations, AT and the NZTA. The architecture of decision-making within these organisations emphasises consistency at a national and regional level, with safety an overriding concern. The neighbourhood-scale design of the Future Streets intervention led to its framing as an outlier, and the novel pedestrian crossings as inconsistent and a potentially risky proposal. Furthermore, decision-making in assessing the proposed crossings within AT and the NZTA focused primary at the scale of the individual device, and so the connections between the device and the broader goals of Future Streets, such as potential health benefits, were not adequately conveyed or considered during that process. Consequently, while the intervention has been considered a success (Mackie *et al*., 2018), there were significant delays in completing the project, hindering the provision of new facilities to the community and jeopardising the research component of the project. Further, with the eventual rejection of the 'enhanced' pedestrian crossing design there was a missed opportunity to trial a potentially beneficial traffic control device.

This case study provides valuable insights into the challenges facing organisations within the transport sector as they attempt to adopt innovative designs and ideas into everyday policy, processes and practice. In order to grasp the complex array of heterogeneous elements involved in transport planning, a sociotechnical assemblage framework was deployed. This framework exposes the integral connection between the social and technical aspects of transport planning decision-making, and the barriers to innovation and possibilities for change that exist. In particular, this perspective provides insight into how everyday decision-making at a micro-political level can lead to the reproduction of existing solutions to transport problems.

This paper argues that business-as-usual practices are embedded as part of a sociotechnical network. Within the transport assemblage, the embedding of particular configurations can create an institutional obduracy (Hommels, 2005) – an inertia and momentum built through the (re)production of shared logics that are both generated by, and generative of, social and technical relationships.

Based on the example provided by the failed attempt to introduce a new type of a pedestrian crossing on Massey Road, a number of conclusions can be drawn about the obduracy of existing solutions to transport planning problems and the challenge of creating space for innovation. The logics, processes and practices identified as relevant within the decision-making in this case study also have implications for contemporary transport planning and urban governance. The following conclusions relevant to wider studies of decision-making and planning can therefore be made:

- The framing of proposals and new ideas or directions has an influence on their potential uptake and traction within decision-making processes. Innovative proposals must capture and address clear policy problems to convince key decision-makers of their value. Within a highly scrutinised and resource constrained (time and funding) environment, such as urban planning and governance, framing new ideas in a way that emphasises their applicability to existing policy problems and governmental concerns is likely to generate better responses and commitment of resources. Otherwise, there is a likelihood that logics of consistency are likely to cause such proposals to be framed as unnecessary or incompatible with existing solutions, be identified as a 'risk' and become subject to risk-avoidance practices.

- 'Ownership' of existing solutions is also likely to encourage innovation to be framed as unnecessary or incompatible with existing solutions. Through becoming embedded within a network of sociotechnical relationships, including the logics, processes and practices identified here, existing technologies and design solutions develop ownership, which in turn creates a form of obduracy. Ownership of solutions is encouraged within the NZTA as a method of gaining uptake and commitment from the transport sector. Equally, within AT, collective agreement is strongly emphasised through the 'sign-off' process for new designs. Both practices help to develop ownership of existing solutions. However, while ownership and collective agreement can help in managing risk and increasing consistency, at the micro-political scale of everyday decision-making, such practices can engender resistance to the adoption of new ideas and approaches.

- There is a strong emphasis placed on calculability and predictability within transport decision-making to address the demand for financial and legal accountability. This requirement has led to the development of precise technical design standards. These standards have become a shared expectation across the multiple stakeholders involved in transport projects, as they help to effectively translate outcomes from design to delivery. However, these standards also 'lock-in' particular sociotechnical arrangements and make introducing new designs and approaches difficult to achieve. Consequently, innovation, which necessarily involves change to existing practices and might require technical adaptations, can become construed as problematic, unpredictable and a potentially risky endeavour.

- Additionally, a highly structured decision-making hierarchy has developed as a risk-reducing practice. Such practices function to protect individual decision-makers from exposure to legal and reputational risks. However, the motivation to operate within this hierarchy leaves limited scope for innovation and adaptability to local contexts – all of which compels a path dependency towards maintaining a high level of uniformity and engenders business-as-usual behaviour.

- The scale at which decision-making is segmented within an organisation can also have an impact on the types of problems identified and solutions offered. With regard to Future Streets, the project was designed as a neighbourhood-level intervention. Thus, the transport problems it attended to were at a neighbourhood scale – specifically, health risks associated with low-levels of physical activity, and difficulties and dangers in choosing active transport options for the local community. Yet, the highly segmented structure of decision-making for new TCDs within AT leads to assessment fixed at the scale of the individual device. Thus, the framing of potential risks and benefits from introducing a new TCD is unlikely to capture the potential for benefits from innovation on a larger scale.

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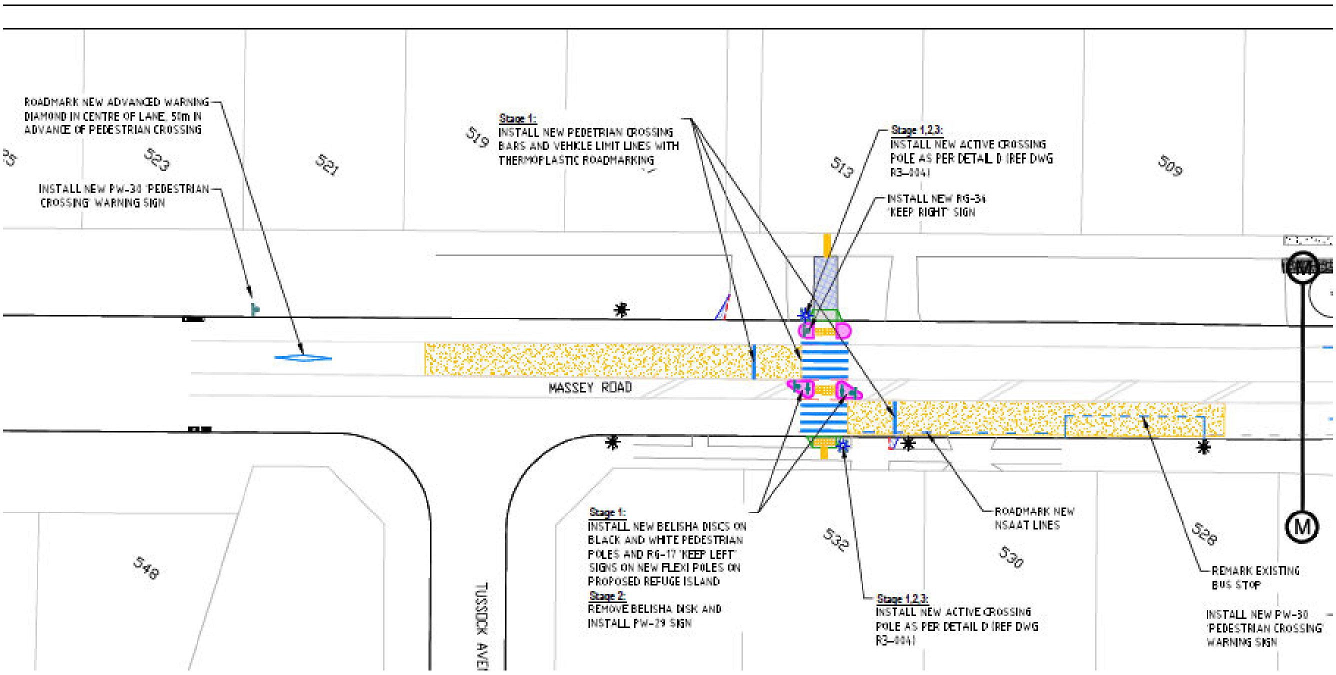
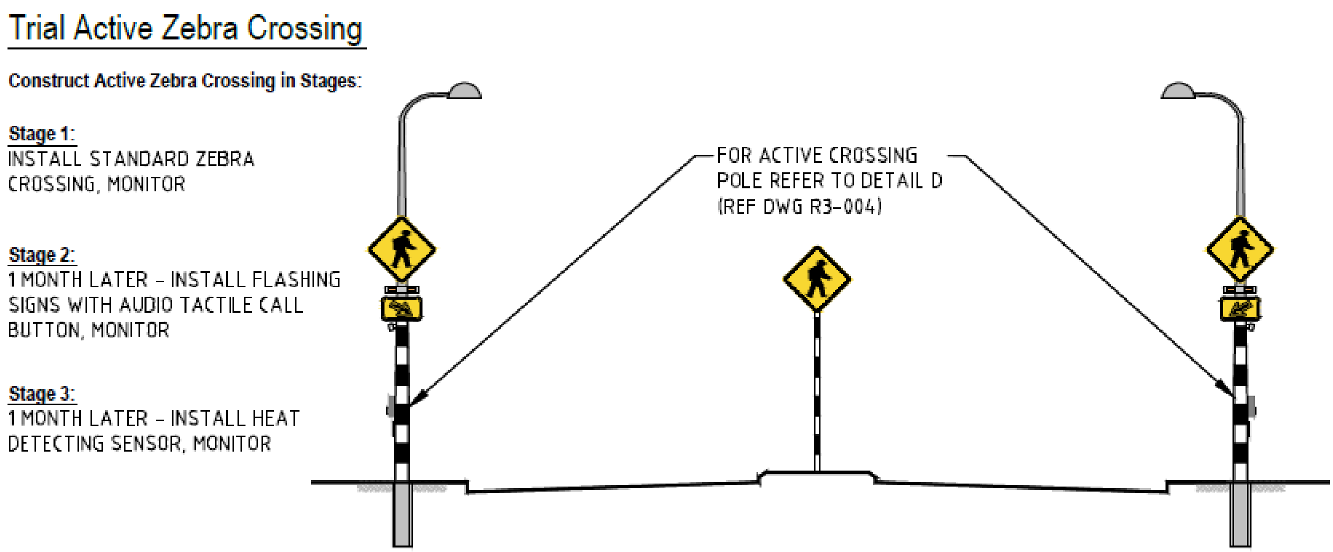
Appendices

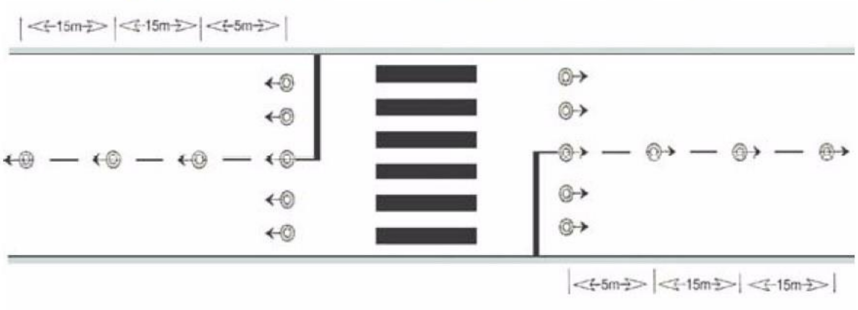
Appendix A: Technical design for the ‘enhanced zebra crossing’ proposed for Massey Road



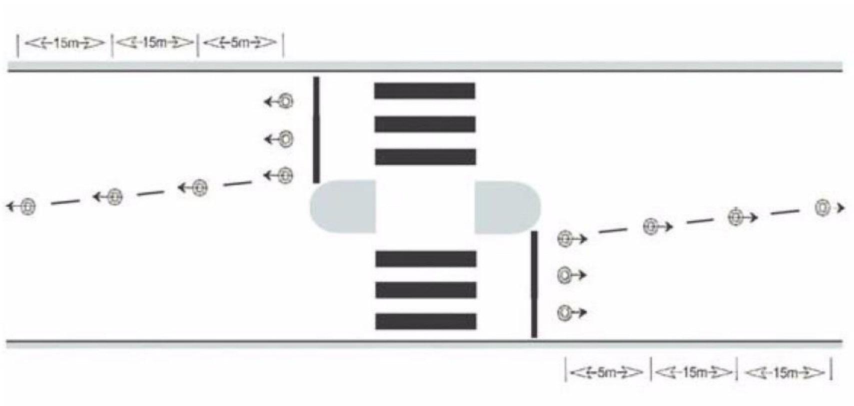


Appendix B: Technical design for the existing solution, 'augmented' zebra crossings

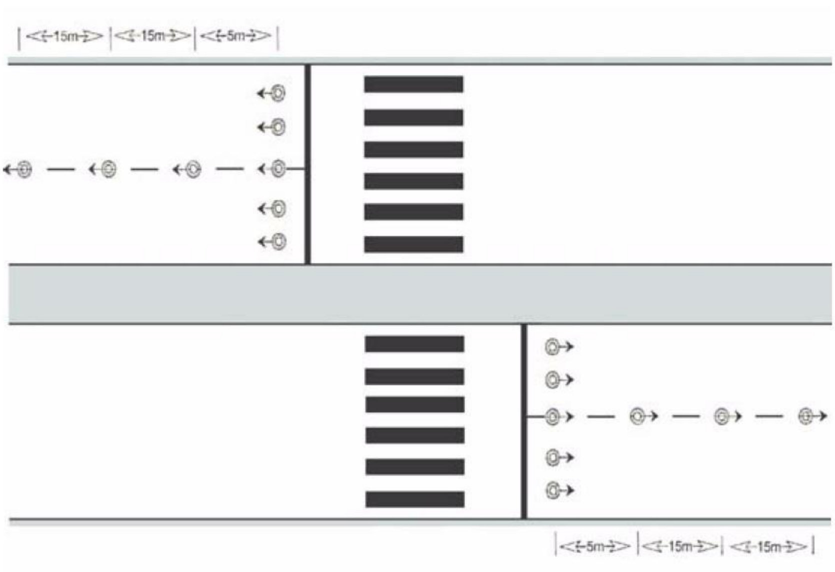
[M1-4 - Placement of warning lights – not to scale



Two-lane, undivided roadway



Two-lane, undivided roadway with pedestrian island



Divided roadway