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*Benefits from more Efficient Infrastructure
Investment Decision-Making*

REPORT TO
INFRASTRUCTURE NEW ZEALAND
www.principaleconomics.com

OCTOBER
2022

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This report was prepared by Dr Eilya Torshizian and Dr Milad Maralani.
The assistance of Eugene Isack is gratefully acknowledged.
The authors would like to especially thank the peer reviewer of this report, Dr Adolf Stroombergen.

Acknowledgements

The authors would also like to gratefully acknowledge the contribution to this project from the following:

- Claire Edmondson (*Infrastructure New Zealand*)
- Sean Myers, Arnaud Deutsch and Angus Gabara (*WSP*)
- Barry Dowsett (*Waka Kotahi*)
- Chris Parker
- Todd Chandler (*Hellmann Worldwide Logistics*)
- Don Good (*Waikato Chamber of Commerce*)
- Mike Ross (*C&R Developments*)
- Kelvyn Eglinton (*Momentum Waikato*)
- Hamish Bell and Rosie Spragg (*Tewaka*)

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Executive Summary

Aotearoa New Zealand suffers from an infrastructure deficit. Without the key infrastructure needed for our economy to thrive, we are depriving future generations of significant economic prosperity. While transformational infrastructure projects need time to be developed into sound technical solutions, many New Zealand projects are being further delayed by policy decision and financing constraints.

In this novel application of the infrastructure Wider Economic Benefits approach, we quantify the cost to society of these further delays for the first time, by using the example of the Waikato Expressway. We used our subregional Computational General Equilibrium (CGE) model to estimate the downstream benefits of the Expressway. At a high level, results of our analysis quantify the annual benefits of having the Expressway in the economy. If the expressway is not functioning as early as possible, **\$334 million of economic benefits are forgone each year**. For further details see Figure 1.

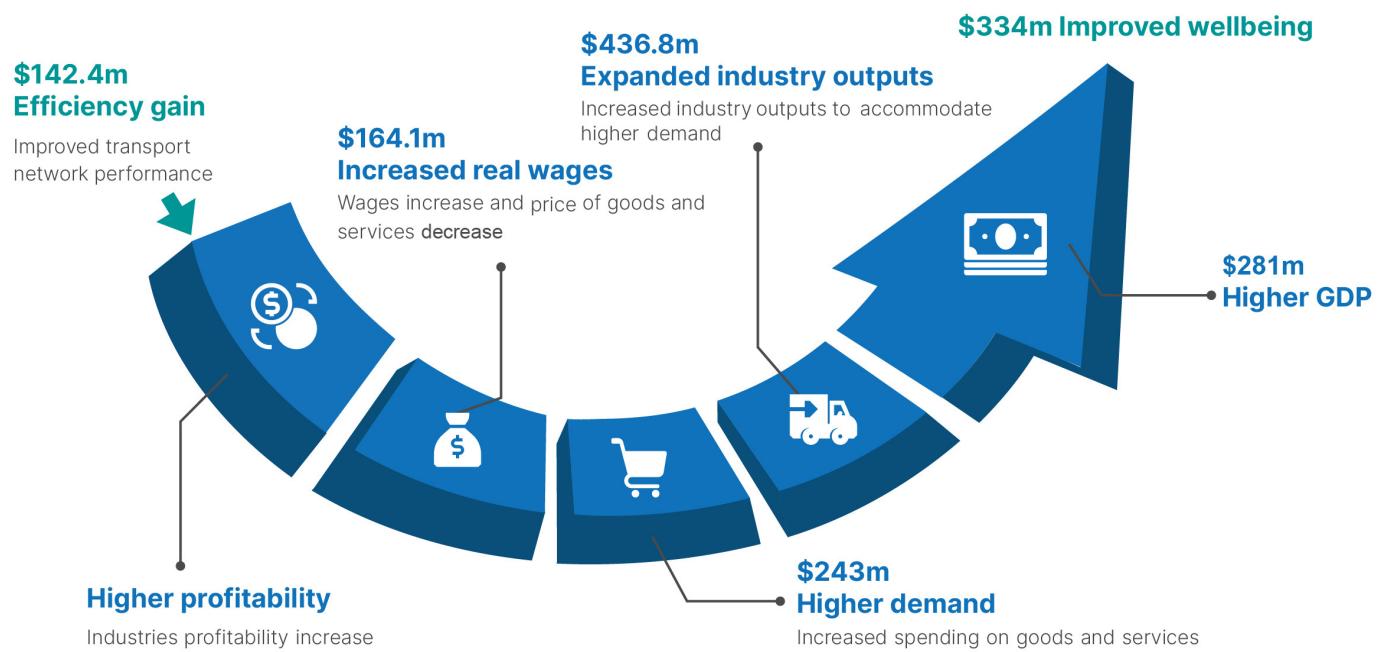


Figure 1: Efficient infrastructure decision-making process of the Waikato Expressway led to economic gains and improved wellbeing outcomes for New Zealand communities

Note: The estimated figures are not additive. The sum of benefits is equal to \$334m per annum, which includes the identified economic and safety benefits.

We investigated the completion timeframe for a range of projects across New Zealand and compared this timeframe with a couple of similar projects in Australia and New Zealand. Accordingly, we suggest that there is potential for a minimum seven-year time saving by decreasing the current 15-year completion timeframe to eight years. Applying this timesaving to the Waikato Expressway indicates that the New Zealand economy would have secured \$2.3 billion of benefits from improving the IDM process. This implies that **the delays have led to a minimum forgone benefits of 1.2 times the total capital cost of the project** (which is approximately \$1.9 billion). To put this in context, the estimated forgone benefit for the Waikato Expressway is almost equal to the Climate Emergency Response Fund for transport, energy and industry in The Budget 2022, and significantly higher than the capital cost of the health infrastructure (\$1.3 billion).

A range of useful policy directions can help overcome this costly problem in the medium term.

Various uncertainties lead to decision-making delays

Delays are caused by a range of uncertainties at the planning phase, including demographic and population, macroeconomic, technological, climate change and political uncertainties.

Regulatory changes and policy frameworks are moving in a positive direction, but will take time to become effective

A range of factors lead to delays in the decision-making process, including:¹

1 Te Waihanga – Infrastructure Commission's Strategy provides a comprehensive list of potential improvements in the decision-making process. (New Zealand Infrastructure Commission, 2022, pp. 183–190).

- ☒ Poor coordination amongst the organisations making decisions
- ☒ Consenting delays driven by various factors
- ☒ Effective financing arrangements, including public-private partnership (PPP)
- ☒ The monopoly power of councils in providing infrastructure to service land
- ☒ The RMA planning process (and infrastructure provision)

Various regulatory changes and policy frameworks intend to address this costly issue. This includes the directions provided by the Infrastructure Strategy, Resource Management (RM) reform, and the National Policy Statement on Urban Development (NPS-UD 2020). Most importantly, we suggest that the following objectives have significant implications for the delays in the planning phase:

- ☒ To improve transparency through providing national direction, and inclusivity through local devolution.
- ☒ To increase the quality of advice through careful considerations of scenarios and pathways, and by accounting for separation and sequencing of options.

However, these policy changes are in their early stages and will potentially take a decade to implement.

Aotearoa New Zealand can secure these forgone benefits

- ☒ Planning is an essential phase of the decision-making process. To ensure that perfect is not the enemy of good, it is critical to **add further flexibility in the decision-making process to improve the timing of decisions**. Principal Economics (in press) investigated the use of adaptive decision-making to provide further flexibility in the planning phase. The report suggested a range of methods for considering all possible outcomes when selecting options for further investigation. This implies that there are times when the two-stage (or multi-stage) phasing of developments provides the appropriate manner to resolve economic, political and/or technological uncertainties ahead of further irreversible investments, thereby reducing the chance of a white elephant scenario.
- ☒ To ensure best use of time, we suggest measuring the magnitude of the costs of delays, and monitoring

those costs during the decision-making process. This report provides an estimate of the cost of delays using the Waikato Expressway as its case study.

We suggest addressing uncertainties and monitoring costs of delays in the decision-making process – the next steps:

- ☒ Uncertainty is an important driver for delays. We suggest providing flexibility in the decision-making process to push past uncertainty. We suggest that new evaluation and (adaptive) decision-making tools can be developed from our findings to study and assess whether the risks and financing costs of fast-tracking infrastructure projects are worth taking.
- ☒ To prioritise investments, it is important to compare apples with apples. We suggest considering an extra portfolio for 'long-term investments'. It will also be helpful to consider evaluation methods for nation building programmes as a package. This needs to be investigated further in a future study.
- ☒ We acknowledge that there are potential benefits associated with further investigations during the initiation and planning phases, by improving the initial idea and accounting for a wider range of uncertainties. It is unclear whether the benefits outweigh the costs. Identifying and estimating the potential benefits from delaying a decision is beyond the scope of our assessment and could be investigated in a future study.
- ☒ Our investigation of the potential time savings from an efficient decision-making process suggested that a 15-to-eight rule could be applied. This time saving calculation is based on a few comparable examples identified in New Zealand and Australia. In case of the Waikato Expressway, our investigation suggested that the decision-making process could be 7 years shorter (applying the 15-to-eight rule). Benefits of infrastructure projects vary significantly depending on the features of impact area. We suggest that our estimate of forgone benefits from a one-year delay in decision-making for the Expressway provides an indicative figure for the costs associated with delays in decision-making of a reasonable infrastructure project. Future research could apply our method and further investigate the potential time savings using a wider range of examples.

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CHAPTER 01

Introduction



Delays in decision-making processes have been a major reason for prolonged periods of excess demand for different infrastructure, which has led to overuse, congestion and eventually dampened economic growth. Infrastructure New Zealand commissioned Principal Economics to assess the economic impact of delays in infrastructure investments.

1.1 Scope of this Report

This report estimates the cost of delay in infrastructure decisions, by using Waikato Expressway (the Expressway) as its case study. For this analysis we:

1. Estimate the economic and employment benefits of the efficiency gains and the resulting direct, indirect and induced (flow-on) effects of the Waikato Expressway (the Expressway);
2. Provide a description of the potential efficiency gains from making better early-stage decisions in major infrastructure projects;
3. Discuss technical and policy values, including separation and staging, centralisation and devolution, and the quality of advice.

1.2 Efficient Decision-Making

The efficiency of the infrastructure decision-making (IDM) process is reflected in the timeliness of the planning process; that is, the time that it takes from the initiation of the project idea to the execution phase. The recent Infrastructure Strategy report by Te Waihanga – Infrastructure Commission suggests that the New Zealand planning system slows down essential infrastructure projects:

“

“New Zealand suffers from long delays between project planning and delivery. Many infrastructure projects must go through a resource consent or designation process. Resource consent applications typically require detailed analyses of the environmental, social, cultural and economic impacts of projects. They’re tested through a hearings process that has been described as adversarial, with the right to appeal decisions to the Environment Court or High Court. This process can take a long time and is costly for everyone involved.”

NEW ZEALAND INFRASTRUCTURE COMMISSION, 2022, P. 134

We investigate the impact of a more efficient infrastructure decision process, which could potentially reduce the 15-year decision-making process to eight years.

1.3 The Downstream Benefits of Efficient Infrastructure Decisions

Understanding the economic, social and environmental benefits of efficient decision-making requires looking at its downstream impacts across different sectors of the economy, based on productivity improvements to businesses and households.

The recent Te Waihanga – Infrastructure Commission infrastructure strategy emphasised the importance of better decision-making and highlighted that:

“

New Zealand is one of the least efficient high-income countries when it comes to turning public investment into quality infrastructure. International evidence shows that good decision-making, supported by robust public investment management and a stable long-term pipeline of investment intentions, is essential for lifting performance.”

NEW ZEALAND INFRASTRUCTURE COMMISSION, 2022, P. 109

This report provides an estimate of the cost of inefficient decision-making, as reflected in the delays caused from inefficiencies in the decision-making process.

A better decision-making process primarily leads to improved productivity for the users of different infrastructure types, such as the transport and construction sectors. This leads to gains for the businesses and households who directly or indirectly relate to those primary infrastructure users.

For example, if the planning phase of a road improvement project is completed within eight years instead of 15 years, assuming no changes in the other project phases, the freight sector could start benefiting from improved access 7 years earlier.² This improved access leads to positive downstream effects on all other businesses and households who directly or indirectly use the goods and services transported by the freight companies. The outcome of this is improved consumption and social wellbeing, and potentially reduced transport emissions.

The benefits from improved decision-making are not limited to one town, city, or region. The outputs of improved decision-making in one area are linked to other areas through the supply chain links.

2 Our reasons for considering a 7-year time saving in the planning phase of IDM are provided in Section 2.1.

This report captures the direct and indirect (downstream) benefits of efficient infrastructure decisions using our subregional Computational General Equilibrium (CGE) model.

In addition to efficiency gains from improved outcomes for businesses and households, an efficient infrastructure decision-making process leads to improved environmental outcomes, lower labour turn-over from improved project sequencing, and improved opportunities for future developments.

1.4 Our Approach and the Structure of the Report

To estimate the economic cost savings from avoiding delay in the infrastructure decision process, we estimated the forgone economic activities from delaying the completion of Waikato Expressway by one year. We acknowledge that the opportunity cost of all infrastructure projects is not equal and suggest that the Expressway provides a gauge of the potential cost of delaying a reasonable infrastructure investment decision.

For our estimation,

- We update the estimates from the earlier strategic evaluation by Parker et al. (2008) to estimate the direct benefits from the Expressway.
- We apply the updated direct benefits to our CGE model to estimate the downstream effects across different sectors and regions.

In the next chapter, we provide a description of the infrastructure decision-making process, the reasons for delays and potential solutions for avoiding them. We also provide a description of the economic and policy context, including the recent changes in policy frameworks to accelerate decision-making.

Chapter 3 provides background information about the case study of this report – the Waikato Expressway – and a description of the findings from previous studies and the potential impacts of the Expressway.

Chapter 4 provides our findings from estimating the Wider Economic Impact of the Expressway and present our findings. We then conclude and provide further discussions.







Background



New Zealand's infrastructure – its roads, rails, bridges, waterways, energy facilities, telecommunications networks, and other public assets – support the country's economic activity, trade and commerce, both domestically and internationally. However, the significant growth in the demand for infrastructure services over the last few decades has not been accompanied with corresponding growth in and maintenance of their supply. This is because infrastructure is not allocated through a price system but through public investments, which implies that an increase in demand does not raise prices or signal the value of increased supply. This lack of supply response has systematically created excess demand for different infrastructure, which leads to overuse, congestion and eventually dampened economic growth.

The country's infrastructure assets, which are owned and funded by a mixture of central and local government entities as well as private sector stakeholders, are being used far beyond their intended capacities and useful lives. For example, the lack of transport infrastructure increases the costs for Auckland households and businesses from road congestion, with an estimated annual cost of between \$0.9 and \$1.3 billion (NZIER, 2017).

Having the necessary infrastructure capacity to provide more housing is a driver of house prices. One reason for less permissive planning regulations is the lack of infrastructure to support the brownfield and greenfield growth. Hence, the appropriate timing of the provision of infrastructure contributes to an increase in housing supply and leads to lower house price growth. There are multiple

issues with the provisions of infrastructure, particularly around the inefficient decision-making for infrastructure investments.

The funding and financing issues and the potential inefficiency of government have been cited as drivers of the infrastructure shortage. Discussions have been held regarding the importance of further alignment between legislation, particularly between the Resource Management (RM) system and infrastructure planning, to ensure efficient outcomes from infrastructure investments. The empirical evidence on the efficient use of the available infrastructure and its interaction with other factors of supply, particularly planning regulations,³ is limited.

The general context of this report is in the areas of investment decision-making (how to prioritise one project over the other), impact of infrastructure investment on economic growth, overlaid with discussions of infrastructure policy and wellbeing. The present section provides further details on these topics. The policy discussions will be provided in Section 5.1.

2.1 Infrastructure Decision Delays

Five phases comprise a project's lifecycle management: initiation, planning, execution, monitoring and control, and closure. In this study, we consider the efficiencies in the first two phases of project management, and the economic costs from lengthier project initiation and planning. **We acknowledge that there are potential benefits associated with further investigations during the initiation and planning phases, by improving the initial idea and accounting for a wider range of uncertainties. It is unclear whether the benefits outweigh the costs. Identifying and estimating the potential benefits from delaying a decision (if any) is beyond the scope of our assessment and could be investigated in a future study.**

The recent New Zealand Productivity Commission report noted that the existing infrastructure deficit has led to a failure to align investment rates with population growth. The report suggests that it is important to build the assets needed to support more people in the community ahead of time:

“

“The inability or unwillingness in the past to fund this infrastructure suggests that pre-pandemic rates of inwards migration will not be sustainable in the future.”

NEW ZEALAND PRODUCTIVITY COMMISSION, 2021, P. 38

The Infrastructure Strategy report suggested that there are a range of reasons for delays in the IDM and construction process. This includes poor coordination amongst the organisations making decisions. The report gave the example of the Auckland's Northern Busway, which was conceptualised in 1987 but not completed until 2008. This 21-year timeframe was caused by the number of planning and funding agencies involved (The Royal Commission, 2009). Another example is Auckland's second busway, which had a timeframe of over 20 years. The report compared the busway projects' timeframe with Brisbane's first busway, which only took six years to complete (it was proposed in 1995 and completed in 2001) (Tanko & Burke, 2015). Since then, two other busways have been completed in Brisbane between 2004 and 2011.

As we will discuss in the next sections, the planning timeframe is potentially longer for major infrastructure projects. For example, in the case of Waikato Expressway, there has been a 40-year timeframe between the initiation of the improvements in State Highway 1 extensions between Auckland and Waikato and the execution. However, since we do not have a comparable case in other countries, we rely on the examples provided by Infrastructure Strategy and suggest that there is a potential for significant time saving in the IDM's planning process, from the current 20 years to six years. This is assuming a fixed time needed for the construction of projects across Australia and New Zealand.

Our further investigation of other significant national projects across New Zealand suggests a minimum 15-year timeframe for their completion. For example, the City Rail Link's (CRL) detailed study of underground route started in

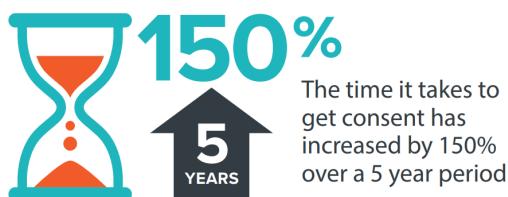
³ Planning regulation refers to the policies and rules – largely contained in district plans – that govern the use and development of land in and around cities. Key examples analysed in the literature examined in this section include urban boundaries, height restrictions, viewshaft corridors, minimum carpark requirements and restrictions on infill development.

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2009 and the project is planned for completion by 2025. The first consultation for the Waterview Tunnel started in 2000 and the tunnel opened in 2017. The Transmission Gully's public consultation started in 2008 and the project completed in 2022. The Ara Tūhono – Pūhōi to Warkworth route's public consultation started in 2010 and the road opens in 2023. We suggested that the 15-year timeframe is a minimum planning and construction timeframe because there is at least one year delay between first concepts and public consultation. Also, the timeframe from initiation until preparation of concepts is unclear – this is because it is difficult to define an exact date for the initiation of projects.

Figure 2: \$1.29 billion annual cost of consenting projects



Based on this information, we suggest that it is reasonable to aim for a 7-year timesaving in the IDM process by decreasing the 15-year project completion timeframe to 8 years.

The Infrastructure Strategy refers to the importance of a range of other factors to improve the efficiency of IDMs. An important factor is the role of consenting delays in lengthening the IDM's planning phase. As shown in Figure 2, the estimated costs of consenting is \$1.29 billion per annum (Sapere, 2021). Another important factor is to consider effective financing arrangements, including, for example, public private partnership (PPP).⁴



Source: New Zealand Infrastructure Commission (2022, p. 136) and Sapere (2021)

There are a range of regulatory requirements for infrastructure projects, primarily driven by the Resource Management Act (1991), Government Policy Statement, Local Government Act, and the National Policy Statement on Urban Development. We will present these policy frameworks in Section 5.1.

4 Te Waihanga – Infrastructure Commission Infrastructure Strategy report suggests that the current PPPs in New Zealand have been delivered on-time and on-budget for the Crown, with delays of less than six months.

2.1.1 Improved timing of investments and providing flexibility in decision-making process to avoid future bottlenecks

Infrastructure decision delays often lead to insufficient land for housing and business developments. New developments require large upfront investments by councils or developers. Infrastructure can be a bottleneck (McEwan, 2018; Productivity Commission, 2017).⁵ Mechanisms to connect benefits and costs of growth struggle to provide sufficient infrastructure, even if the land is suitable for house building (Johnson et al., 2018).

The lack of infrastructure has been noted as a constraint that has led to zoning restrictions (Grimes & Liang, 2009; Martin & Norman, 2020).⁶ Bassett et al. (2013) discussed the monopoly power of local councils in both granting consents and providing infrastructure. They questioned the efficiency of this system in terms of providing infrastructure required for growth and being accountable for that. They specifically refer to the monopoly power of Watercare in Auckland and its power in extracting rents out of developers and not being accountable to ratepayers.

The costs of infrastructure have been noted as a prohibitive factor for recent developments. The operating costs of the infrastructure sector has increased gradually over the last two decades (between 2000 and 2020) by 22 percent – for details, see Appendix A. Grimes and Mitchell (2015) documented the costs of the rules and regulations as perceived by developers. Auckland developers responding to a survey noted that they were asked to fund key community infrastructure beyond that directly related to their own project. Unavailability of infrastructure caused 13 percent of respondents to abandon a project and 38 percent noted that the costs of providing infrastructure influenced abandonment.⁷

The Productivity Commission's (2012) housing affordability inquiry suggests that the monopoly power of councils in providing infrastructure to service land and the access to development contributions may incentivise councils to designs that have higher initial capital expenditure.

The Productivity Commission's (2017) inquiry into better urban planning suggested that supply is rationed reflecting perceived difficulties in financing, recovering costs and burdening existing residents. Limited supply is often the binding constraint to meeting demand for development in high-growth cities. The inquiry called for more cohesive plans linked to infrastructure supply, market-based tools and infrastructure pricing. The inquiry recommended that the long-term infrastructure (and land-use planning) needs to account for the uncertainties involved in the decision-making process.

MRCagney et al. (2016) cited BERL (2016) for the RMA planning process (and infrastructure provision) contributing to a very long time to convert land from current zoning to new business use. Some participants suggested that it took between seven and 15 years to complete this process.⁸ Parker (2015) noted that houses cannot be built without costly infrastructure, which takes time to plan and deliver with funding and financing challenges.

Skidmore (2014) compared New Zealand housing trends and policies with those of the United States. The author cited Albouy (2009) regarding how the US urban area price differential between undeveloped and developed land on the fringe is approximately equal to the cost of converting agricultural land into development (that is, costs of infrastructure). The author noted that development contributions offer a needed source of infrastructure funding but may also increase housing prices and

5 Author notes the costs of providing infrastructure is underestimated. It is also noted as being seen by planners as the most important constraint by a considerable margin.

6 Bassett et al. (2013) estimated the council costs for roads, footpaths, drains, and other infrastructure at around \$85,000 per section, the cost of water and sewerage at around \$20,000 per house, and the cost of building consent at around \$40,000 per house. Except for the cost of building consent, which is sourced from the Statistics New Zealand Official Yearbook (2008), the authors do not provide their calculations/sources for other cost estimates.

7 Additionally, developers feel that Watercare and Auckland Transport were engaging in monopolistic behaviour to force them to fund upgrades and expansion of infrastructure where the benefits extended beyond their development. Some developers abandoned their projects due to issues over access to infrastructure or cost of upgrading the existing infrastructure. In this survey, respondents (developers) could give multiple responses, which is why totals do not add to 100 percent.

8 Authors note that building infrastructure too early will mean additional costs due to the opportunity cost of capital – 10 years in advance imposes a cost of \$36,874 per dwelling and five years ahead is associated with a cost of \$17,938 per dwelling.

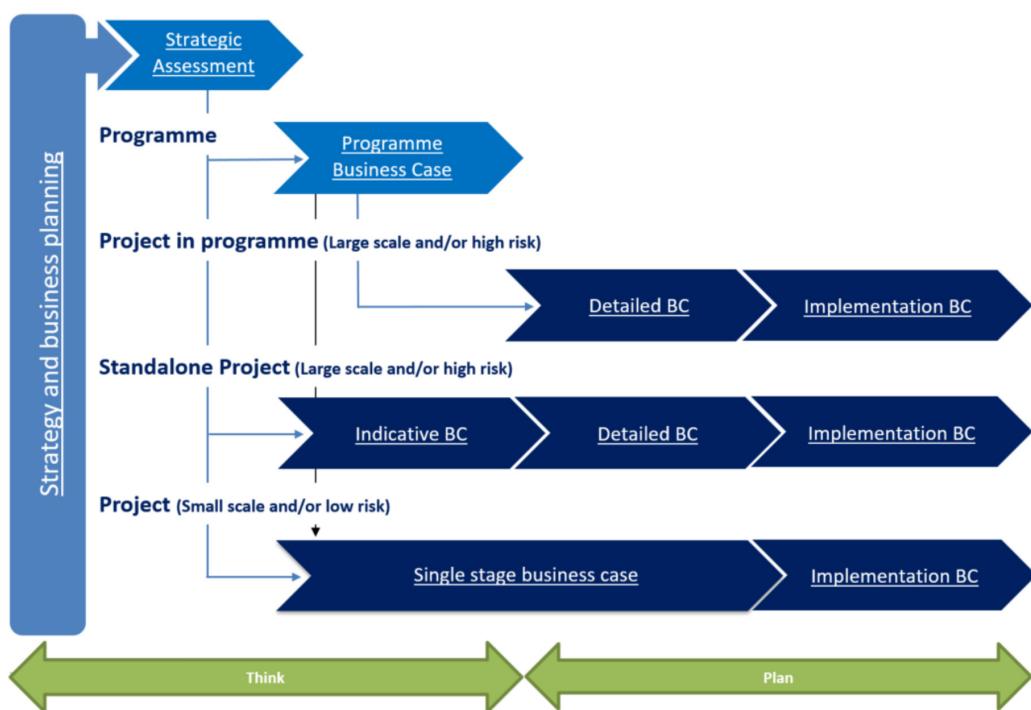
reduce the construction of more affordable and dense development.

As the Productivity Commission (2017) noted, councils have faced difficulties recovering the full costs of infrastructure from those creating the demand. This has led many councils to ration the supply of new infrastructure, contributing to scarcity and higher land and housing prices. Further investigation of the politically and practically sound funding and financing solutions is currently underway.

2.1.2 Delays are driven by a range of uncertainties

Business cases are an important management tool to ensure infrastructure investments provide value for money. There are multiple guidelines and tools provided by the Treasury and Waka Kotahi to ensure accuracy of business cases (The Treasury, 2022; Waka Kotahi, 2020). Figure 3 shows the strategy and business planning steps, starting from the strategic context. The detailed business case evaluates the social, wellbeing and economic costs, benefits and risks of the short-listed options to identify the preferred option.⁹

Figure 3: Strategy and business planning



9 The preferred option is the one that leads to optimum public value for delivery of the project.

Source: *The Treasury* (2022)

2.2 Economic Impact of Infrastructure Investments

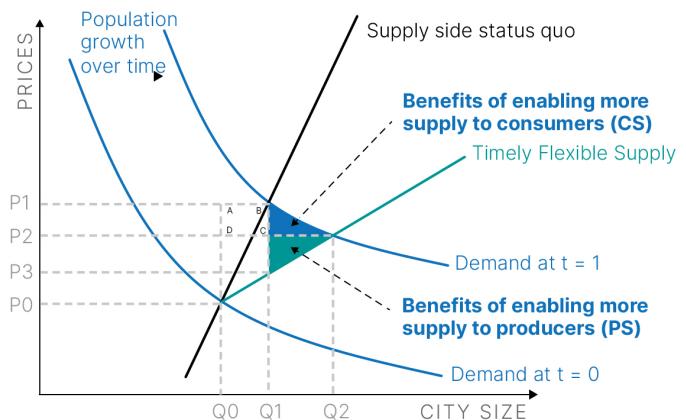
The level of infrastructural development influences national competitiveness, and there is strong evidence that transport infrastructure plays a vital role in economic growth (Holmgren & Merkel, 2017; Sahoo & Dash, 2009). The Council of Economic Advisors estimates that a 10-year, US\$1.5 trillion program of infrastructure investment could add between 0.1 and 0.2 percentage points to average annual real growth in gross domestic product (GDP) (CEA, 2018). A simple conversion of this figure to the New Zealand size of GDP implies that a \$2.45 billion annual infrastructure investment is associated with an average real GDP growth of between \$325.5m and \$651m.¹⁰ These figures are likely to be over-estimated because the multiplier method used for the CEA assessment does not account for economic sectors' competition for available resources.¹¹

An efficient decision-making process leads to an increase in the supply of different types of infrastructure, including roads, bridges, and water pipes, which leads to an improvement in the features of living environment and housing.

To provide an economic framework, Figure 4 illustrates the impact of increased supply. Initially, the supply of infrastructure services is at Q_0 , which implies a price of P_0 , consisting of the implicit (opportunity) and explicit costs to the consumers of services. With increases in population over time, demand for infrastructure services increases and the demand curve shifts outwards (to Demand at $t=1$) with a quantity demanded equal to Q_1 and the price of P_1 . A more flexible supply would lead to an increase in quantity of infrastructure services from Q_1 to Q_2 , and a decrease in prices from P_1 to P_2 . This will lead to an increase in existing users' surplus by the area of the P_1 -B-C- P_2 rectangle. In addition, a portion of population who were crowded out of the market due to their limited affordability could now enter the market and use the services. This includes migrants from overseas or from other regions. Therefore, an infrastructure shortage will lead to a loss in consumer

surplus to the new users equal to the blue triangle area and a loss in producer surplus equal to the green triangle area.

Figure 4: Impact of Supply Shortage



Source: *Principal Economics*

In the short run, additional infrastructure spending may affect GDP in the year in which the spending occurs, generating direct and possibly indirect economic impacts. If the increased spending is offset by equivalent increases in taxes or declines in spending, then these short-run effects would likely cancel out. However, to the extent that additional spending is financed via increased deficits and the economy is below full employment, the infrastructure spending here would represent net additions to government spending and could therefore generate direct short-term spending impacts, which could then be amplified or diminished by subsequent indirect impacts.

Recent evidence suggests that the net impact of additional government spending is positive; that is, the spending multipliers exceed zero (Auerbach & Gorodnichenko, 2010; Ramey & Zubairy, 2017). Auerbach and Gorodnichenko found that these multipliers are larger during recessions, while Ramey and Zubairy found no evidence that multipliers

¹⁰ This figure provides an estimate of the potential impact of infrastructure investment. However, the return on investment and the structure of the New Zealand economy are significantly different from that of the US.

¹¹ This implies that an increase in infrastructure investments comes at a cost to other sectors of the economy in terms of the allocation of labour and capital.

are higher during periods of slack. Abiad et al. (2014, 2016) found that increased infrastructure spending, during recessions in particular, can raise GDP through demand-side multiplier relationships.

2.2.1 Impacts of time saving in the IDM process

There is strong evidence that transport infrastructure plays a vital role in reducing trade costs through increased trade facilitation, which leads to higher economic growth (Camisón-Haba & Clemente-Almendros, 2020; Holmgren & Merkel, 2017; Timilsina et al., 2020). The transportation data firm INRIX (2019) estimated that the congestion costs of each American for nearly 100 hours account for approximately US\$1400 a year. Regarding road transport, the American Transportation Research Institute (2018) estimated that traffic delays in the trucking industry cost US\$74 billion every year. Graham et al. (2020) argued that optimal time, costs, and quality are three critical issues for infrastructure decision-making. They discussed that although New Zealand's ease of doing business performance is quite impressive and is top globally, the country's overall productivity is relatively low compared to the OECD average. According to the New Zealand Productivity Commission (2021), Kiwis work relatively long hours: 34.2 hours per week compared with 31.9 hours per week in other OECD countries. However, New Zealanders produce less: \$68 of output per hour compared with \$85 of output per hour in other OECD countries. This lower labour productivity could be driven by lower capital-labour intensity, including infrastructure. Camisón-Haba and Clemente-Almendros (2020) empirically explored how transport costs influence trade, supply chain, and a country's global competitiveness.

Transport-related costs are a significant issue in the agri-based industry due to goods' bulk size and perishable nature. New Zealand's most prominent categories of exports are agricultural and horticultural and highly dependent on Chinese and Australian export markets, which comprise two-thirds of its exports. New Zealand's export intensity (27 per cent) is the lowest among small OECD economies and is poorly integrated with global value chains (GVCs),¹² partly due to its geographical isolation and poor physical infrastructure, and high trade costs. Hummels and Schaur (2013) estimated that each day in transit is equivalent to an ad-valorem tariff of 0.6–2.3 percent. Transport-related trade costs may be one of the main reasons for higher market costs, leading to the higher market price of goods but lower profit margin in New Zealand. Efficient physical transport has a significant positive impact on trade facilitation, logistics services, supply chain management and the cost of doing business, which leads to increased economic activities.

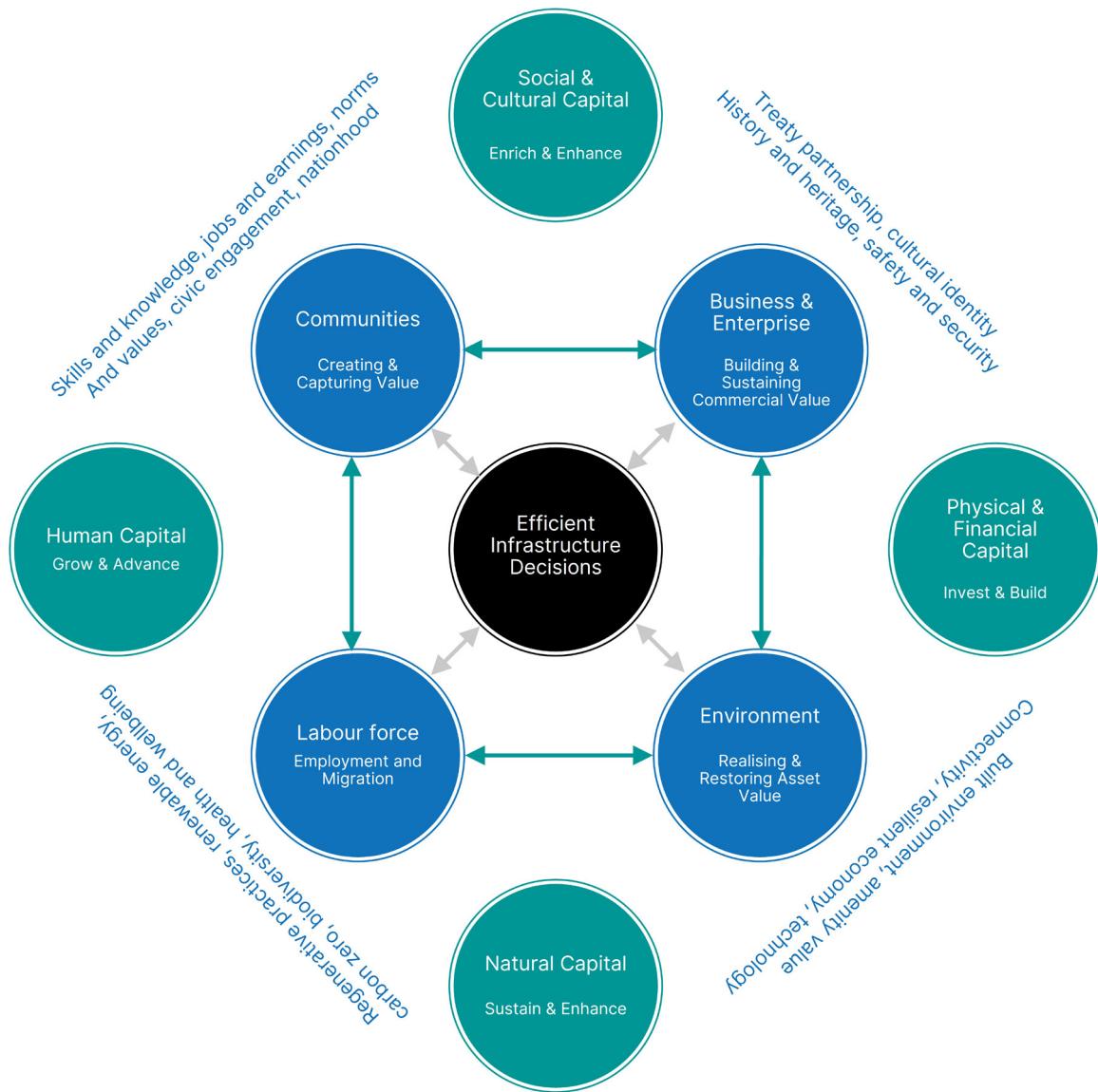
Under this background, we have estimated the impact of the Waikato Expressway in terms of its benefits for inter-regional trade. Products that are made in one region and need to be shipped to other regions for domestic consumption or export face a transport cost. Therefore, there is a gap between the price of a commodity at origin and the final price consumers are paying. In our study, we ask, "If the Waikato Expressway didn't exist, how much cost would be imposed on the NZ economy due to higher transport costs?" The counterfactual in our model is to not have the Waikato Expressway in the economy. Therefore, our results show the annual impact of the Expressway. With each year's delay in the construction of the Waikato Expressway, this cost is imposed on the NZ economy.

2.3 Wellbeing Context

Efficient infrastructure decisions lead to an improvement to different domains of wellbeing and contribute to a resilient economic growth. This is consistent with the schematic presented in Figure 5, which shows the contribution of efficient infrastructure decisions to businesses, communities, labour force, and environment, leading to

improvements in the four capitals (as identified in the Treasury's (2021) Living Standard Framework). The impact of timely infrastructure investments on quality of life and quality of business, leads to changes in the choice of location of skilled labour, affecting the prospects of growth across cities and regions, as well as other features of living environment.

Figure 5: The contribution of efficient infrastructure decisions to the Treasury's four capitals



Source: Principal Economics, based on the four capitals presented in Treasury's (2021) LSF¹³

13 For The Treasury's (2019) living standard framework, see [here](#).



Waikato Expressway



The Waikato Expressway is the case study of this report for evaluating the cost of delays in decision-making. In this section, we provide a description of the Expressway and its impact on the economy.

3.1 40 years of Planning

The discussions around improving mobility between the Auckland and Waikato regions date back to 1970s, when the initial suggestions were made regarding extensions to State Highway 1. This idea evolved until early 2000s and led to the idea of the Waikato Expressway. While there is always a

level of uncertainty involved and further planning is required to address that, there is a large gap of almost 40 years between the initiation of the idea and start of the project in 2009.¹⁴ This phase included both the project initiation and the planning phases.

The primary objective of the Expressway, as highlighted in the National State Highway Strategy (NSHS), is to provide high levels of service for long-distance through-traffic travelling between Auckland, the Waikato, the Bay of Plenty and further south.

¹⁴ While the initial idea was to upgrade the State Highway 1, and it may be argued that the initial stage was not part of planning for the Expressway, we suggest that a comprehensive initial scenario planning should have considered the Expressway as an option.

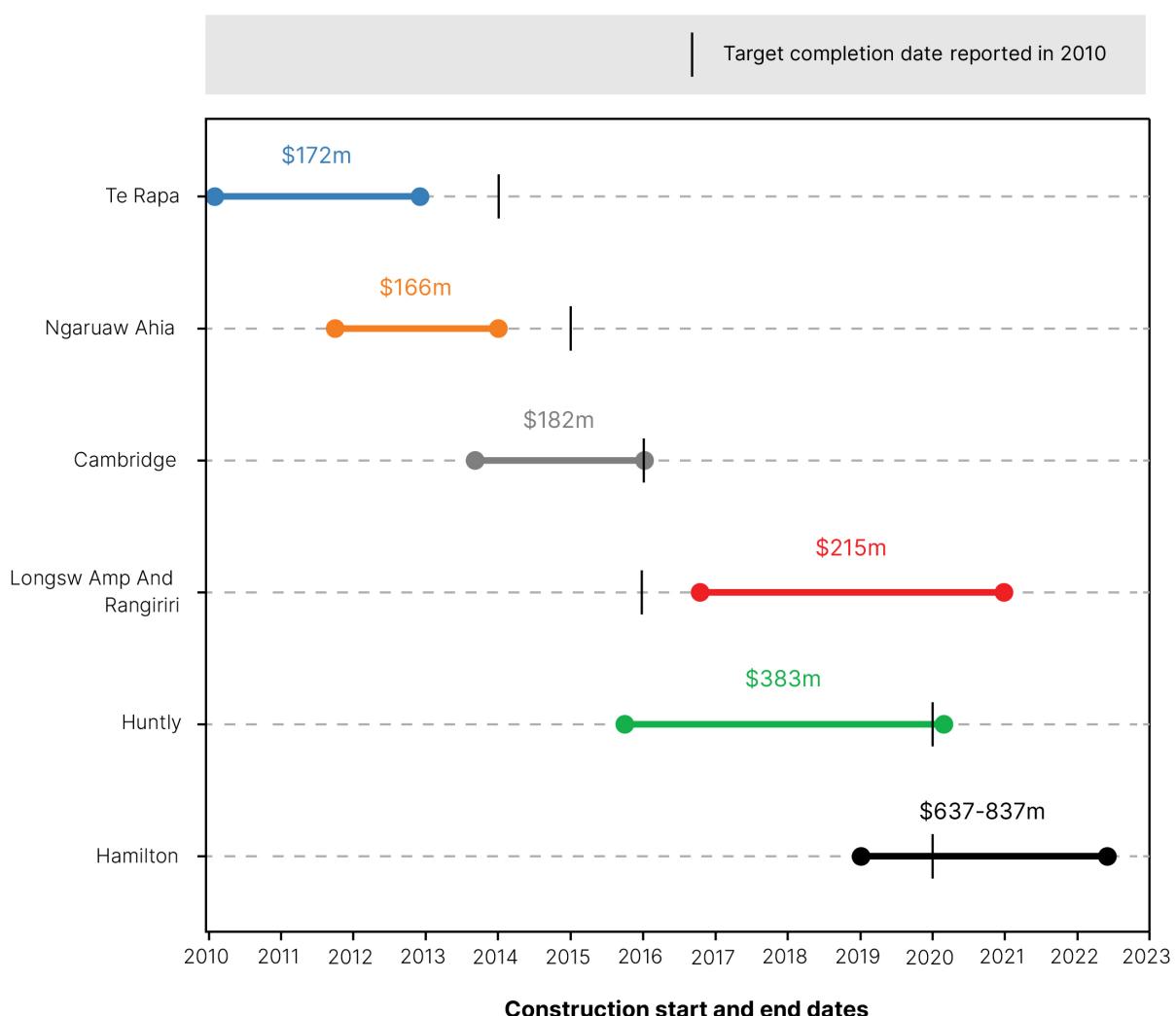
While the Waikato Expressway was not officially designated as such until the early 2000s, the upgrading of State Highway 1 (SH 1) from the Bombay Hills to Mercer from 1992 to 1993 can be considered the first step in the construction of the expressway. This upgraded the SH 1 from the end of the Southern Motorway to just north of Mercer from two lanes to four. Also, the Pōkeno bypass was constructed around this time, in addition to separated interchanges to allow access for local property owners along the route. This is interesting because it provides a useful example of how adaptive decision-making could

add value by providing flexibility for future decisions, and also provide immediate value to communities from smaller developments. This relates to our discussions in Section 2.1 about the importance of adaptive decision-making.

Figure 6 shows the timeframe of different phases of the Expressway. The last phase between Lake Road interchange and Tamahere was under construction until recently and opened to traffic on 14th July 2022. Details on the location and length of different phases of the Expressway are shown in Figure 7.

Figure 6: The timeframe for different phases of the Expressway

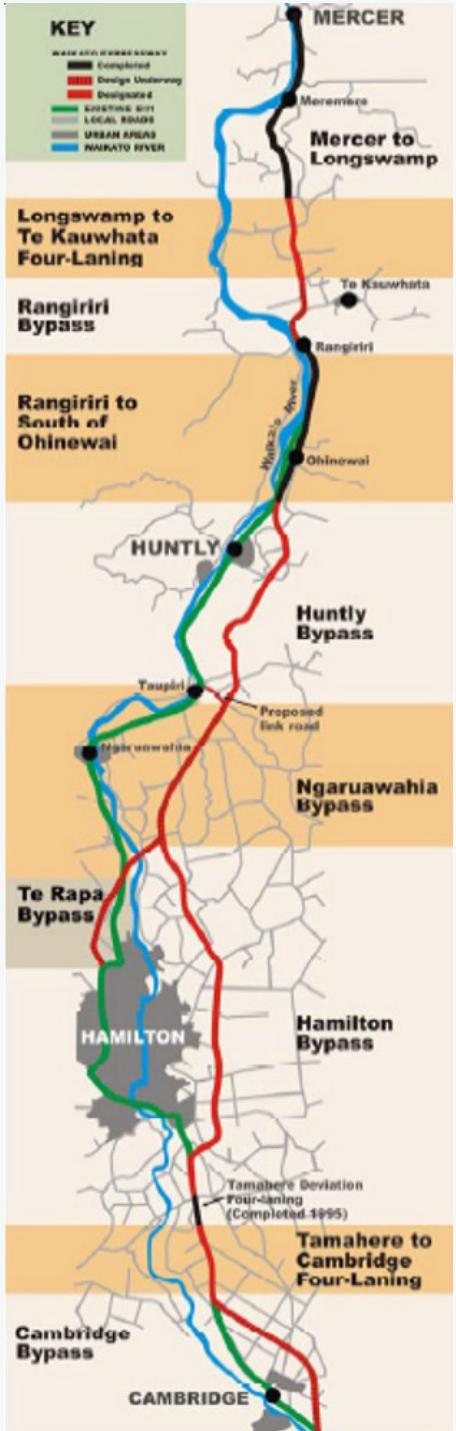
Timeframe: 2010–2022, Waka Kotahi NZ Transport Authority estimated construction costs



Source: Beehive, Waka Kotahi NZ Transport Authority

Note: Estimated project costs shown in Figure 6 are for construction only. Target completion dates are sourced from a snapshot of the Waka Kotahi NZ Transport Authority website as of 2 June, 2010. Construction dates and costings have been sourced from Beehive and Waka Kotahi NZ Transport Authority media releases and project overviews. We combined construction costs and timings for Longswamp and Rangiriri to maintain consistency with past reporting of Waikato Expressway sections.

Figure 7: Waikato expressway sections as defined in March 2010

Section name	Length	Description
Pokeno section, Mangatawhiri 4 laning, Mercer to Longswamp section Completed		
Longswamp to Rangiriri section to move to design stage in 2020	5 km	
Rangiriri section to move to design stage	4.5 km	
Ohinewai section Completed		
Huntly section - design tendered Feb 2010	15 km	
Ngāruawahia section - in design stage	12.5 km	
Te Rapa section - construction contract let March 2010	7.2 km	
Hamilton section - design to be tendered Mid 2010	21 km	
Tamahere to Cambridge Four - Laning to move to design stage in 2010	3.8 km	
Cambridge section - in design stage	11 km	

Source: Waka Kotahi NZ Transport Authority (2010)

3.2 Previous Studies of the Impact of the Expressway

Some studies have investigated the direct and indirect impacts of the Expressway.

Parker et al. (2008) completed a strategic evaluation of the Waikato Expressway, providing estimates of the direct impacts of the Expressway. That report investigated the importance of the Expressway to the New Zealand economy, although the authors noted that they did not consider the (indirect) wider economic impacts. We will provide a description of the direct impacts captured by Parker et al. (2008) in the next section.

Infometrics (2009, 2010) provided an economic impact assessment of the roads of national significance (RoNS), including the Waikato Expressway, the Auckland Western Ring Route, Tauranga's Eastern Link, the Puhoi to Wellsford Motorway, the Victoria Park Tunnel, the Christchurch By-pass, and Wellington to Foxton at a national level. The reports capture the efficiency gains and corresponding capital accumulation from the RoNS investments. The results suggest that the \$2.65 billion investment in RoNS (SAHA, 2010, p. 42) raised annual GDP by \$1.4 billion (expressed in 2008 prices).

The findings of Infometrics' (2010) economic impact analysis of the Expressway are shown in Table 1. The wider economic benefit of the Expressway was equivalent \$385 million in 2020.

Richard Paling Consulting (2010) estimated the employment impacts of the RoNS and the Expressway, based on the agglomeration impacts (that is, the productivity effects).¹⁵ Their results suggested that the Expressway led to the creation of 800 new jobs and the RoNS created 2,600 new jobs.

Table 1: The wider economic impact of Waikato Expressway

Compared to the Do-Minimum scenario

Unit: % change compared to the Do-Nothing scenario; dollar values expressed in million dollars – 2008 prices.

Impact On	Impact in 2020 (% change)	Impact in 2020 (\$ value)
Consumption	0.14	\$254
Exports	0.17	\$121
Imports	0.09	\$74
GDP	0.17	\$385
RGNDI ¹⁶	0.14	\$335

Source: Infometrics (2010, p. 1)

3.3 Description of the Direct Impact of the Expressway

As Parker et al. (2008) highlighted, there are a range of benefits from the Expressway, including:¹⁷

3.3.1 Economics and Social Impacts

The Expressway reduces production costs and improves competition through reduced costs for heavy commercial vehicles (HCVs). The Auckland, Waikato and Bay of Plenty regions account for over 50 percent of New Zealand's manufacturing and distribution businesses.¹⁸

¹⁵ These estimates take into account the potential for part of the employment impacts to be relocated rather than being new jobs. The estimates are based on the guidelines provided in the Waka Kotahi's MBCM – the older version was called Economic Evaluation Manual – EEM (Waka Kotahi, 2021).

¹⁶ The main measure of economic welfare used in the CGE modelling is Real Gross National Disposable Income (RGNDI). RGNDI measures the total incomes New Zealand residents receive from both domestic production and net income flows from the rest of the world and adjusts for changes in the terms of trade.

¹⁷ We updated the listed impacts to align with most recent policy recommendations.

¹⁸ In 2021, 51 per cent of Geographic Units in Manufacturing, Transport, Postal and Warehousing sectors were in Auckland, Waikato and Bay of Plenty regions (Statistics NZ, 2022).

The migration of businesses and households to the Waikato region, particularly from south of Auckland, has added value through decreased cost of production for businesses, through improved accessibility, and decreased housing (and other relevant) costs for households.

The Expressway contributes to the government policy objectives to decrease congestion in Auckland and unlocking productivity growth and importing social and cultural connections between regions (New Zealand Government, 2018, p. 2).

3.3.2 Network Performance and Safety Impacts

The Expressway reduces travel time between Waikato and Auckland by up to 35 minutes (20 percent) between Auckland and Hamilton, and by 35 minutes between Auckland and Tirau.

Relocating the traffic from SH1B and SH27 on travels between Auckland to Tirau leads to a lower maintenance cost of those roads. This is particularly important for HCVs because the Expressway is better suited for heavy traffic (than another road).

The improved road suitability for heavy traffic helps accommodate greater truck numbers, weights and speeds, which leads to improved economic activity.



Photo Source: Waka Kotahi NZ Transport Agency

¹⁹ Parker et al. (2008) used 2008 figures to calculate the savings from fewer fatal crashes, which equates to a total of \$38.5 million per year. We use a value of \$4.85 million cost per crash for all movements and vehicles, assuming 100km/h speed limit fatal injury adjusted by the 1.1 crash cost savings update factor under the MBCM to determine a total crash cost saving of \$53.35 million per year.

²⁰ For further details about this development, see [here](#).

The four-lane divided route of the Expressway results in 10 fewer fatal crashes per year, equating to a saving of \$53.35 million per year.¹⁹

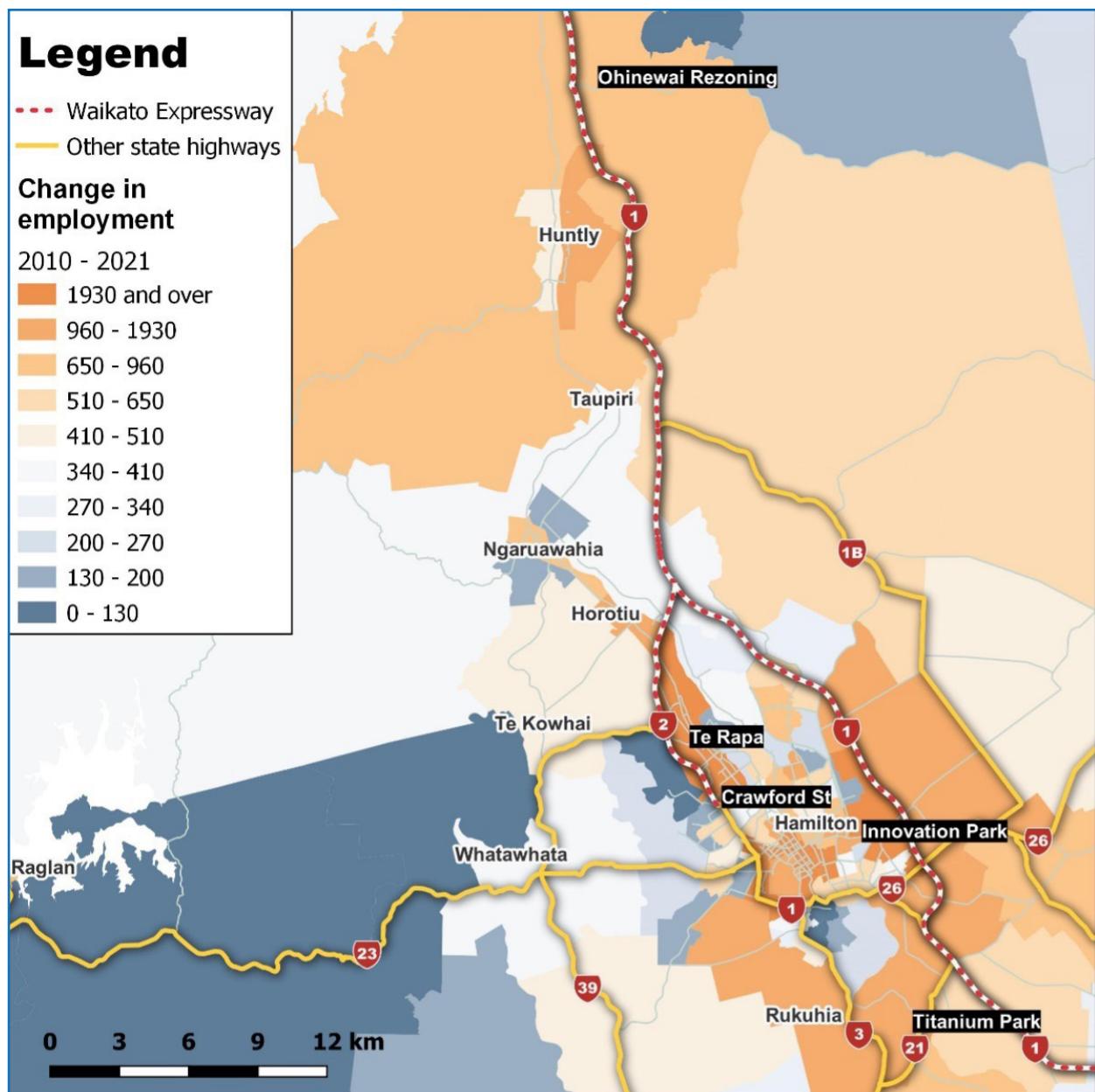
3.3.3 Tourism

The Expressway facilitates the access of international tourists between Auckland, Taupo and Rotorua. Also, the Expressway improves access for the domestic tourism between Auckland and the 'golden triangle', which comprises Coromandel, Waikato and the Bay of Plenty.

3.3.4 Land Use Planning

The Expressway leads to improved commercial and industrial developments. This includes developments in the Te Rapa district north-west of Hamilton in Horotiu to the north of Te Rapa, the 'Innovation Park' in East Hamilton, at 'Titanium Park' near Hamilton airport, and at Crawford Street Rail Village. An example of a development that occurred as a result of the Expressway is the \$1 billion development in Ohinewai (north Waikato) by Comfort Group, which is a mixed-use development consisting of 1,100 homes for up to 3,000 residents and a new factory with an estimated 2,600 jobs.²⁰ The locations and change in employment between 2010 and 2021 are shown in Figure 8.

Figure 8: Improvements in commercial and industrial developments



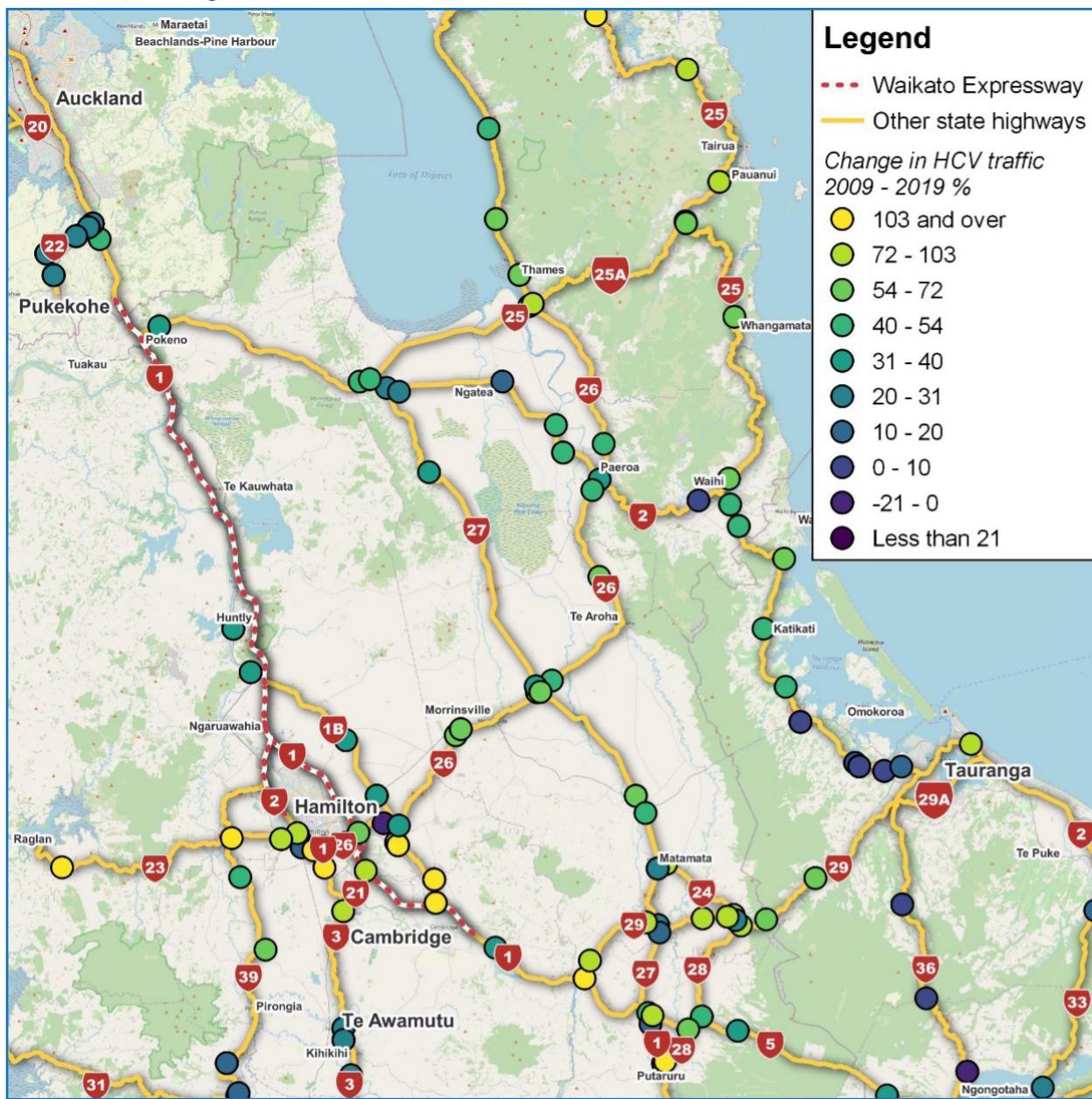
Source: Principal Economics, Waka Kotahi NZ Transport Agency, Statistics NZ

Note: We source employment counts from the Statistics NZ business demography statistics for the years of 2010-2021 at Statistical Area 2 granularity. Locations of state highways are sourced from Waka Kotahi NZ Transport Agency.

Figure 9 shows the implication of the expressway for HCVs along the planned Expressway. Accordingly, we observe a significant increase in HCV around Hamilton and between Hamilton and Tauranga. In comparison, the percentage change in HCV is small and even negative in lower parts (closer to Tauranga). This confirms our initial suggestion that while SH2 is shorter, the reliability and safety of the Expressway has led to increased use of HCV of the Expressway.

Figure 9: Change in HCV travel in the Waikato Road network (2009–2019)

Period: 2009–2019; % change.



Source: Principal Economics, Waka Kotahi NZ Transport Authority, LINZ, Open Street Map

Note: We use Waka Kotahi NZ Transport Authority traffic volume 1975–2020 datasets; 2015–2019 and 2005–2009. Data across datasets are matched data using Site IDs. Heavy vehicle counts are derived using corresponding AADT heavy vehicle percentages within each dataset. We determined the percentage change over the 2009–2019 using these figures. Only sites recording traffic flows going in both directions are shown in Figure 9.

In addition to the impacts captured by Parker et al. (2008), there are a wider range of benefits from interactions among businesses and households. These impacts are beyond the direct benefits of the expressway on transport network. These impacts are the follow-on effects of better transport network. To measure these impacts a general economic modelling framework required. For example, businesses and households benefit from a lower cost of travel/trade, which leads to higher profit for business, a rise in the households' income, and more spending on other sectors of the economy. This will increase economic activities in other sectors that are not directly linked to road transport.

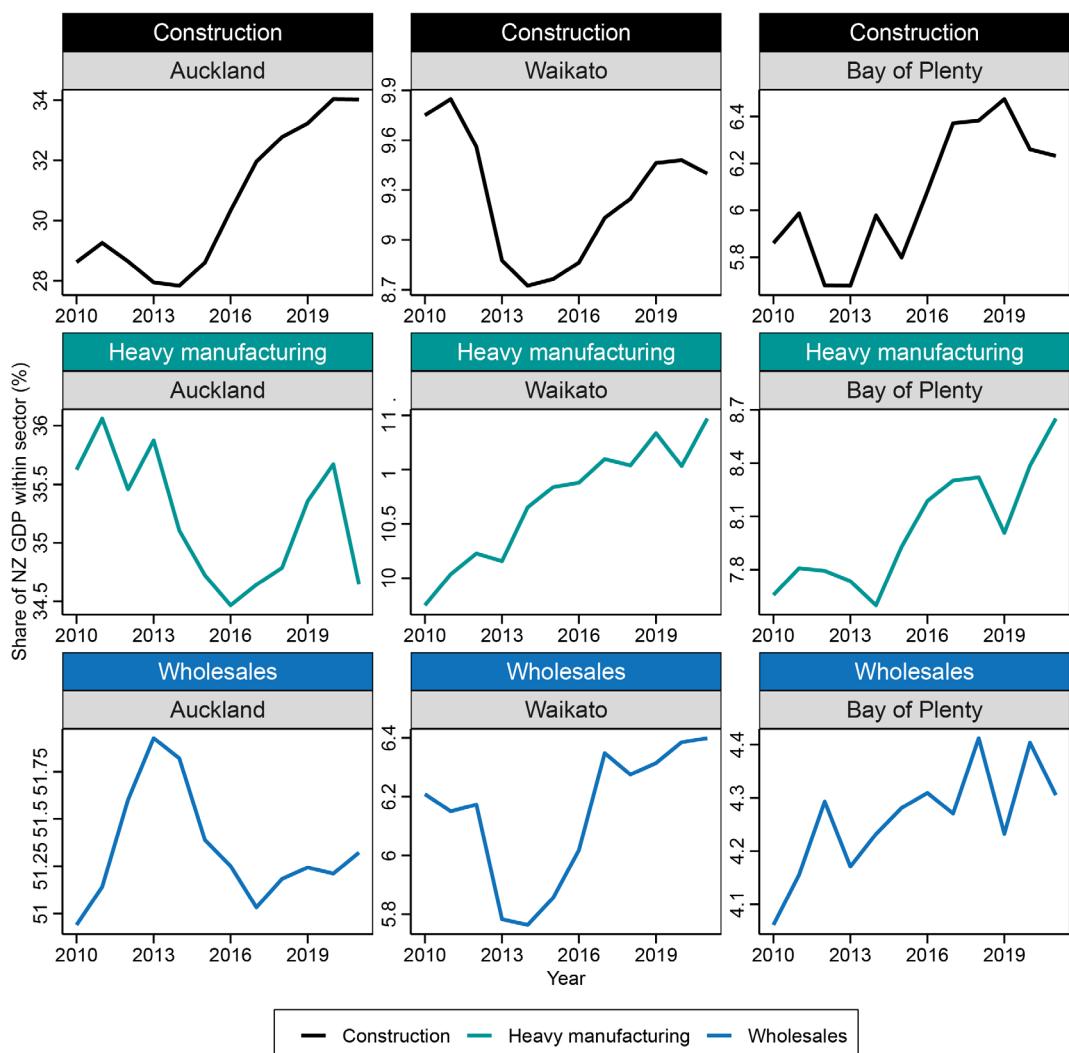
3.4 Expressway's Impacts So Far

This section provides descriptive statistics on the sectors of the economy and changes in employment density and house prices. The descriptive statistics intend to provide additional information on the direction of economic change in the areas affected by the Expressway over the last decade. However, these statistics do not provide any specific information about the impact of the Expressway because of the wide range of other factors at play.

Figure 10 shows the changes in the share of the national GDP of wholesales, heavy manufacturing and construction sectors for Auckland, Waikato and Bay of Plenty (BoP). The figures show data between 2010 (before any of the Expressway was completed) until 2021 (after completion of all phases except for the last phase between Lake Road Interchange and Tamahere). Accordingly, the share of Waikato and BoP of the national GDP of relevant industries has increased over the last few years (the percentage changes are small, but there is a consistent trend). This includes the increases in shares of the wholesale, heavy manufacturing and construction sectors.

Figure 10: Share of each region from GDP of wholesales, heavy manufacturing and construction (%)

Period: 2010–2021



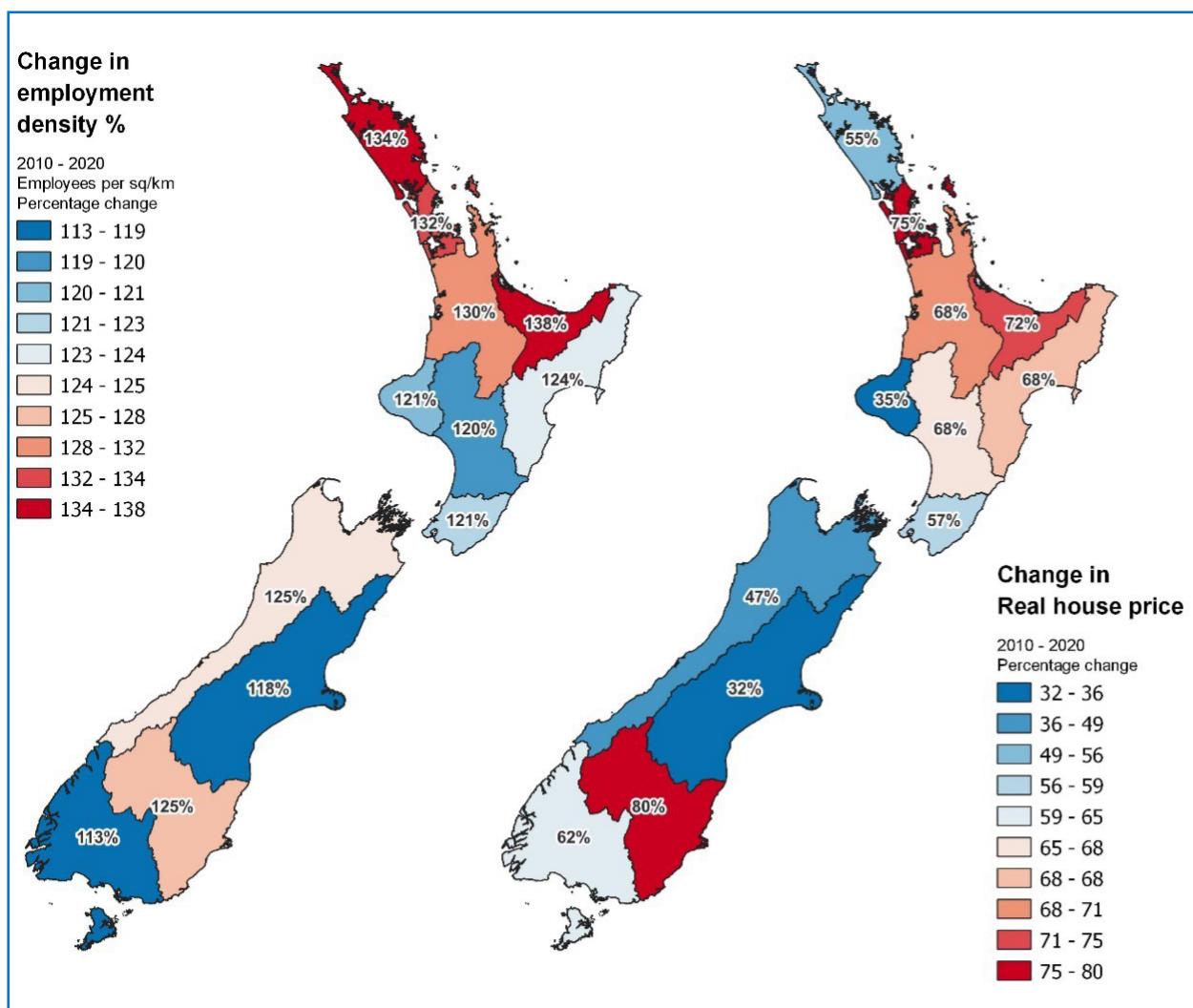
Source: Statistics New Zealand, Principal Economics calculations

Note: The left vertical axis shows Auckland's share of New Zealand GDP for each sector and the right vertical axis shows Waikato's and BoP's share of New Zealand GDP for each sector.

As shown in the left-hand side in Figure 11, employment density across New Zealand regions grew between 2010 and 2020, with significantly higher densities in large urban areas, with a 132 percent increase in Auckland and a significant increase of 130 percent in Waikato and 138 percent in Tauranga. These regions have also experienced some of the highest growth in real house prices over the

same period, with 75, 68 and 72 percent house price growth, respectively – as shown on the right map. In our conversations with the stakeholders, they attributed this increase in desirability of Waikato's labour market (and housing market) to the impact of the Expressway and suggested that **further infrastructure improvement will be the key to addressing labour shortages.**

Figure 11: Growth in employment density and real house prices



Source: REINZ, Statistics NZ, Principal Economics analysis

Note: We use employment data from the Statistics NZ Household Labour Force survey and calculate the employment densities using regional land areas reported in Statistics NZ geographic boundaries files. We amalgamate areas to match those reported by REINZ for house prices to allow for comparisons. We source house prices from REINZ and deflate the reported data for inflation using the Statistics NZ CPI before calculating house price growth.

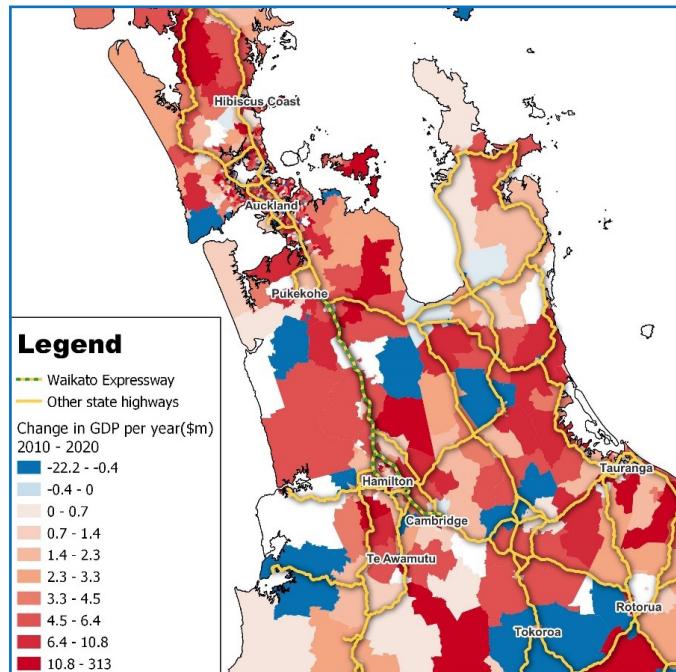
Figure 12 shows the changes in the economic activity (GDP) of construction, heavy manufacturing and wholesales at different distances to the Expressway between 2010 and 2020. Accordingly, there is a trend to further increase

in economic activities in areas located closer to the Expressway. This suggests that, in addition to the overall increase in economic activity that we described in Figure

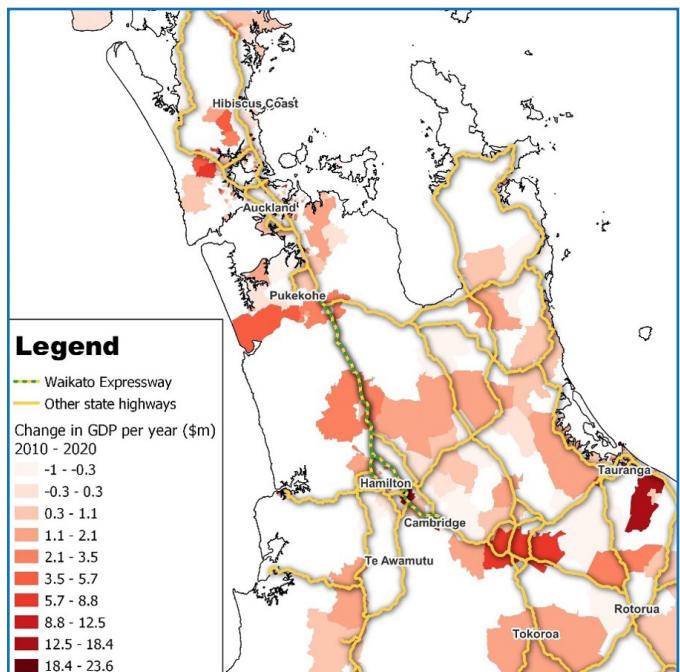
10, there is a relocation of economic activities from farther areas to the areas closer to the Expressway.²¹

Figure 12: Changes in GDP of sectors by location

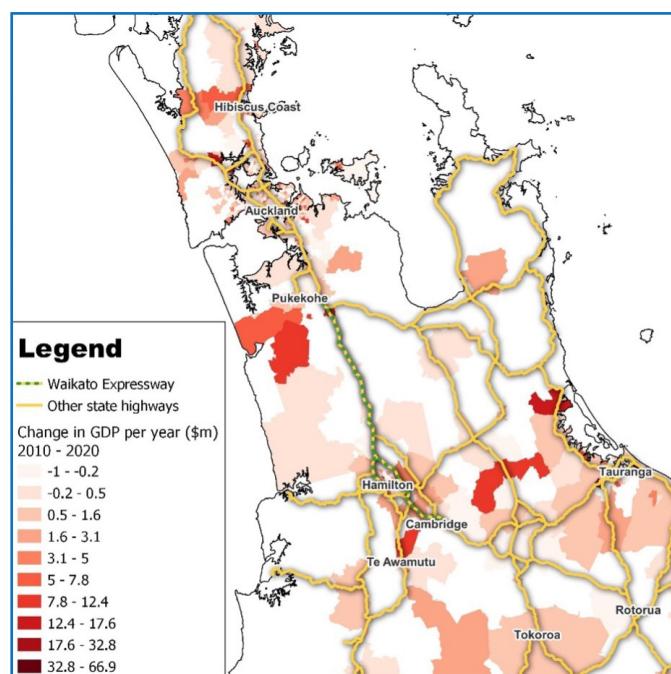
Change in Construction GDP %; period: 2010–2020



Change in Wholesale GDP %; period: 2010–2020



Change in Heavy Manufacturing GDP %; period: 2010–2020



Source: Statistics NZ, Principal Economics analysis

21 The increase in the GDP of the construction sector in areas nearby the Expressway is potentially to source local industries, quarries etc.



Our Approach



To capture the economic impact of delays in infrastructure decisions, we consider both the direct and indirect benefits. The direct benefits include the improved network performance and safety improvements as described in Section 3.3, such as transport network performance and safety improvements.

To measure the downstream impact of the Waikato Expressway, we use a methodology used by Rokicki et al. (2021). They used a regional CGE model to capture the effect of a high-speed high-capacity motorway in Poland and its regions.

We estimate the impact of the Expressway in terms of its benefits for inter-regional trade. Products that are made in one region and need to be shipped to other regions for domestic consumption or export face a transport cost.

Therefore, there is a gap between the price of a commodity at origin and the final price consumers are paying. In our study, we asked, ***"If the Waikato Expressway didn't exist, how much cost would be imposed on the New Zealand economy due to higher transport costs?"*** The counterfactual in our model is to not have the Waikato expressway in the economy. Therefore, our results show the annual impact of the expressway. With each year's delay in the construction of the Waikato expressway, this cost is imposed on the New Zealand economy.

For this study, we need to first identify the direct impact from the Expressway and then estimate the flow-on impacts on businesses and households across regions.

4.1 Measurement of the Direct Benefits

For the measurement of the direct benefits, we rely on the earlier evaluation by Parker et al. (2008), cross-checked with inputs from the stakeholders to ensure the findings are still relevant after 14 years. We also use other available statistics to check on the information used in the early evaluation.

The baseline scenario of our analysis is the economy in the absence of the Waikato Expressway. Parker et al. (2008) estimated the impacts of the Expressway using the Waikato Regional Transport Model (WRTM), as shown in Table 2. Accordingly, the model forecasts an overall saving of 24.1 million vehicle kilometres travelled (VKT) in 2017, and 35.8 million in 2030 (assuming no new trip generation).

Table 2: Description of the Do-minimum and the Expressway scenarios

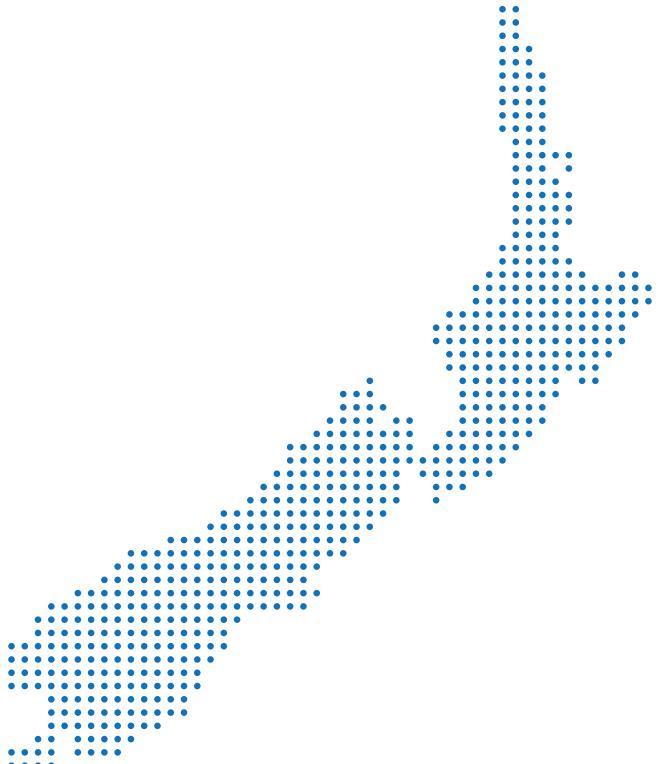
Expressway Section	Model Scenario	
	Do-Nothing (2007, 2017 & 2030)	Expressway (2017 & 2030)
Long Swamp to Te Kauwhata	X	✓
Rangiriri Bypass	X	✓
Church to Avalon 4 lane	✓	✓
Avalon Dr Bypass	✓	✓
Hunly Bypass	X	✓
Ngāruawāhia Bypass	X	✓
Te Rapa Bypass	X	✓
Cambridge Bypass	X	✓
Hamilton Bypass 4 lane	X	✓
Southern Links	X	✓

Source: Parker et al. (2008), Principal Economics

We suggest that the outputs of the model provide a conservative estimate of the impact of the Expressway because:²²

1. The model minimises the generalised cost of travel. Since the distance between Auckland and Tauranga is shorter via SH2, the model forecasts that no traffic will leave SH2 to use the Expressway. However, this is not necessarily correct because the Expressway provides a safer and more reliable driving environment than SH2.²³
2. Based on our discussions with the stakeholders, the suggested time savings are significantly smaller than their anecdotes. For example, the stakeholders suggested a peak hour time saving of 20–30 minutes for Auckland–Hamilton (North) instead of 10–12 minutes as suggested in the model.

Table 3 compares Parker et al.'s HCV modelling outputs (Forecasted 2006–2030) with the actual 2006–2019 annual compounded growth rate for different locations (Actual 2006–2019).



22 This is consistent with the findings of Stuart et al. (2018).

23 Between 2009 and 2019, the HCV's Annual Average Daily Traffic (AADT) increased by 22 per cent at SH1 near Hunly and by 26 per cent at SH2 near Apata.

Table 3: Comparison between Parker et al.'s HCV forecast and actual growth

Unit: % Compounded Growth Rate – annual.

ID	Location	Forecasted 2006-2030	Actual 2006-2019	Forecast - Actual
B	SH1 north of SH1/SH1B Junction	2.7%	2.3%	0.4%
C	SH1 below Cambridge	2.0%	1.9%	0.1%
D	SH1 below Putāruru	1.3%	2.4%	-1.1%
E	SH1 near Tokoroa	4.3%	2.2%	2.1%
F	SH1 near Halletts Bay	1.6%	1.8%	-0.3%
G	SH2 past SH1/SH2 Junction	3.0%	0.7%	2.3%
H	SH2 Waihi	1.6%	1.8%	-0.2%
K	SH2 near Ohinepanea	1.6%	1.2%	0.4%
L	SH3 Below Ōtorohanga	3.3%	1.7%	1.6%
M	SH5 near Tārukenga	2.8%	1.6%	1.3%
N	SH5 near Waipā	2.4%	1.3%	1.1%

Source: Parker et al. (2008); Waka Kotahi NZ Transport Agency (2022), Principal Economics²⁴

4.1.1 Feedback from the stakeholders

We met in person with a wide range of stakeholders, including policy analysts involved in the process of decision-making of the Expressway, road users, business owners, social and economic entities, and discussed the process of decision-making of the Expressway. The purposes of our meeting with the stakeholders were to:

- Cross-check the findings from Parker et al. (2008) with their information/experience of the Expressway.
- Collect further information about the impacts that may be beyond the scope of our analysis and any other feedback about the Expressway.

The findings from the stakeholder engagement about the impact of the Expressway are as follows:

- In our discussion of the findings of Parker et al. (2008), the stakeholders confirmed the identified list of impacts. Regarding the size of identified impacts, the stakeholders suggested that the peak hour time savings are potentially larger. For example, the time savings for Auckland–Hamilton (North) trips are most likely in the range of 20–30 minutes instead of 10–12 minutes.²⁵
- All stakeholders referred to the importance of the safety improvements and reliability. These have led to most Auckland–Tauranga travellers using the Expressway instead of SH2.

²⁴ We derive heavy vehicle traffic counts using the heavy vehicle percentages noted in Waka Kotahi NZ Transport Agency datasets on traffic volumes for the years of 2005–2009 and 2015–2019.

²⁵ The stakeholders' current experience of the impact of the Expressway excludes the under-construction phase between Lake Road interchange and Tamahere. The stakeholders suggested that the positive impacts on travel time and labour force migration, will be even larger once that phase has been completed.

- ⦿ Stakeholders referred to the importance of the Expressway for attracting skilled workers to Waikato and also the positive impacts of the Expressway on housing developments. Particularly around Huntly, the stakeholders suggested that there have been positive impacts on housing developments due to improved safety as a result of the by-pass. Also, there have been significant developments in Cambridge from taking the motorway out of the town.
- ⦿ The improvements from Expressway have significantly improved freight activities across the region, particularly between Hamilton and Tauranga. Stakeholders suggested that there will more improvements in the coming years.
- ⦿ The Expressway has led to Waikato becoming a logistic centre for the Golden Triangle, and there has been significant increase in warehousing and use of Hamilton Airport cargo.

Below are our findings about the importance of improved efficiency of decision-making:

- ⦿ Stakeholders referred to inefficiencies in the planning phase. They particularly suggested the costly process of court hearings.²⁶
- ⦿ Sequencing of the major infrastructure projects was an important factor for civil and engineering stakeholders. They referred to the significant costs of discontinuity in major projects, through disruption in labour retaining and the depreciation of capital stock.
- ⦿ A common input from the stakeholders concerned the importance of flexibility in the development process by considering small developments and providing future options (pathways). This could minimise (the impact of) uncertainties, improve interim economic activities, minimise costs and improve feasibility of future developments.

4.2 Capturing the Downstream Benefits

As described in Section 3.2, previous studies have provided a cost-benefit analysis (CBA) of the Expressway

and a wider economic impact assessment of the RoNS, including the Expressway. Given the significant size of the investment, it is important to consider the allocative efficiency impacts of the Expressway beyond the impacts identified from improved productive efficiency in the CBA. The allocative efficiency impacts include the improved allocation of resources between industries and regions, and not just within industries and regions.

The previous assessments of the wider economic impacts of the Expressway do not account for regional trade. It is important to capture regional trade impacts because many products in the New Zealand economy are produced in one region and consumed in other regions or internationally exported. There is a difference between producers' prices and users' payments in trade costs. If the transport cost is too high, there is no or less demand for products, which means less production and economic activities. Therefore, lower trade costs increase the economic activities and therefore need to be minimised. This impact is above and beyond having a route for trade. For example, road transport was available between Auckland and Waikato even before the Waikato expressway, but the Expressway improved travel time and lowered trade margins. Hence, to capture the allocative efficiencies and the wider economic impacts of more efficient infrastructure decisions, we used our *regional* CGE model of the New Zealand economy.²⁷

4.2.1 Our sub-regional CGE model

Principal Economics' regional and district CGE model is a bottom-up model of the New Zealand economy, capable of modelling 88 areas across New Zealand. Our database includes information on 67 districts across New Zealand and 21 local board areas for Auckland.

The advantage of a regional CGE model compared to a national CGE model is the flexibility to model the impact of policies, programmes, and investments that have a specific effect on regions or cross-region impacts, which sum up to the national impacts.

Our sub-regional CGE model is formed by a bottom-up structure and links a series of independent CGE models for each region that interacts through primary factors and trade. In our CGE model, prices and quantities are separate in each region. Therefore, a high-level detail on

26 As will be discussed, RM reform aims to address this issue

27 Another important reason for using CGE in comparison with CBA is to capture the impacts that in a CBA would be assumed as unchanged. A CGE model captures all the interactions across economic agents (that is, industries and households).

the economy makes this model a valuable tool for many regional impact assessments. Furthermore, the model's particular design provides a unique treatment of transport costs through trade margins. This feature makes the model a perfect tool to capture the impact of improving road transport. Transport costs are defined as transport margins generated by transport services. These trade margins directly affect demand for commodities since they are part of the final price. Therefore, improvement in the road results in a reduction of trade margins, which has a positive long-term economic impact on regional development.

We estimate the impact of the Waikato Expressway in terms of its benefits for inter-regional trade using the static version of our sub-regional CGE model. Products that are made in one region and must be shipped to other areas for domestic consumption or export face a transport cost. Therefore, there is a gap between the price of a commodity at origin and the final price consumers are paying. As discussed, the counterfactual in our model is not to have the Expressway in the economy. Our results indicate the annual economic activity that would be foregone from a one-year delay in the completion of the Expressway project.

4.2.2 Inputs to our CGE model (shocks)

We use the findings from Parker et al.'s (2008) study to measure the size of shocks to our CGE model. As described, they used the Waikato Regional Transport Model (WRTM) and estimated that the Expressway would create \$111 m in benefits (in 2006 prices) in terms of travel time savings (including vehicle and freight time) by 2030. Using infrastructure CPI, we updated their \$111 m figure to \$142.4 m. We use this as an input (a shock) to our regional CGE model to change the margin of road transport for inter-regional trade. We assumed that a \$142.4 m saving occurs between three areas: the Auckland region and the upper North Island, the Waikato region, and the Rest of New Zealand (RoNZ). Our assessment includes the entire Expressway investment programme.

4.2.3 Assumptions of our modelling

Below are some of the assumptions we made for this exercise.

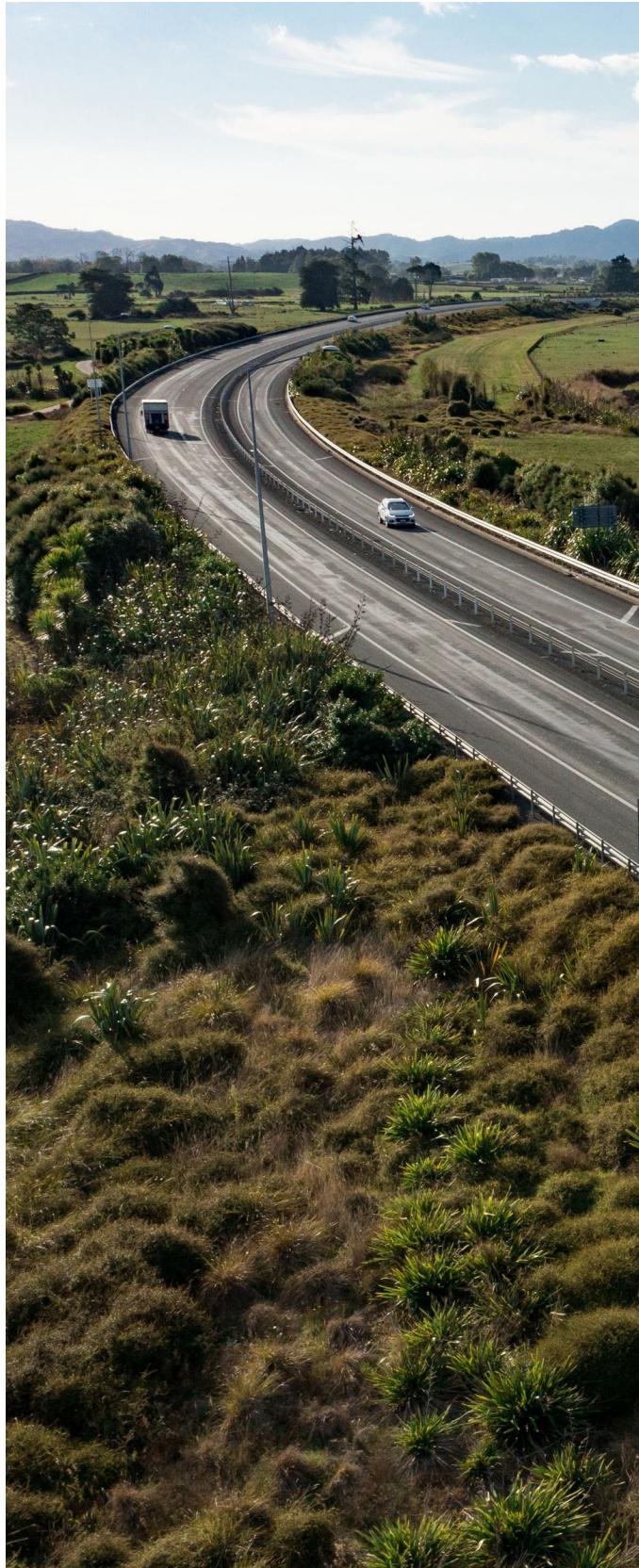
- We only capture the impact of travel time savings on the economy. Other effects (such as construction or safety) are not captured through our current CGE modelling exercise.
- We assume that investment on Waikato Expressway has been funded and there is no impact through investment on the economy. Therefore, we do not shock capital in our model.
- Our model is a static CGE, which means we only show the final impact of having an expressway. Therefore, we do not show the trajectory of how the economy changes over time. Given the purpose of the study – to capture the economic impact of the expressway – the New Zealand economy needs time to adjust and archive to a new equilibrium. These effects happen over time and a dynamic CGE does not provide any further useful information.
- We have aggregated New Zealand regions into three regions: North, Waikato, and South. North refers to areas above Waikato (Auckland, Northland, and Bay of Plenty), and South refers to the rest of the regions, including South Island. We assumed that cost saving happens equally between the northern and southern corridors.

This modelling is a hypothetical experiment because part of the Waikato expressway has already been completed.

4.2.4 Our Results

Our results answer the question, "What would the New Zealand economy look like if the economy saves \$142.4m annually on inter-regional trade margins due to having a more efficient transport network as a result of the Waikato Expressway?" The results show the economy after the construction of the expressway has been completed, and the economy has had enough time to adjust to the new network. Therefore, results are annual change in the economy and compare with business as usual, where the Expressway is not operating in the economy.²⁸

28 We acknowledge that part of this effect has already happened in the economy as parts of the Expressway are completed. However, since the overall purpose of our analysis is a hypothetical assessment of the impact of the Expressway, we suggest that the already-realised effects do not have significant implications for the results of this analysis.



4.2.4.1 National Economic Indicators

Our results suggest that the Waikato Expressway leads to an increase in real GDP of 0.08 per cent or \$281m per year. Other macroeconomic variables are also improving. Household consumption, as a measure of living standards, increases by 0.13 per cent, or \$243 m, as households benefit from a higher level of income and lower cost of delivered products. National exports also rise, taking advantage of the lower-paid cost to international markets. Imports increase by \$548 m annually. Average real wage also increases given the profitability of firms saving costs on shipping products to final users.

Table 4: Macroeconomic impact of the Waikato Expressway

Unit: % Change and \$ million; annual.

	% Change	\$m
Real GDP	0.09	281
Household consumption	0.13	243
Exports	0.05	541
Imports	0.05	548
Average real wage	0.10	

Source: *Principal Economics*

4.2.4.2 Regional impacts

The Expressway has positive impacts across all regions, driven by the lower trade margin for all regions. As shown in Table 5, the GDP gains to Auckland, Waikato and RoNZ are \$86.2 m, \$161.8 m, and \$32.7 m, respectively. Waikato benefits the most, given that the Expressway leads to a significantly higher portion of regional trade passing through Waikato via road. Better access to transport networks reduces the cost of production in the Waikato region and improves regions' access to both domestic and international markets. The Expressway improves households' wellbeing through the improved consumption of goods and services. This is driven by a reduction in final cost of products, because of the lower trade margin, and also by improved (real) income levels, because of higher economic activity – as described above.

Table 5: Regional impact of Waikato Expressway

Unit: \$ million (2022 prices); annual.

	Auckland the upper North	Waikato region	Rest of New Zealand
Real GDP	86.2	161.8	32.7
Household consumption	81.2	116.3	45.7
Exports	190.8	202.5	148.1
Imports	204.3	182.5	161.2

Source: Principal Economics

Table 6 shows the regional impact of employment and wages. The national level of employment is fixed (explained in the closure part of the report); however, workers can move between regions/sectors. Our results indicate an increase in the employment level in the Waikato region as labour forces move towards a higher level of income, which is reflected in real wage improvements.²⁹

Table 6: Regional employment and wages

Unit: % change; annual.

	Auckland the upper North	Waikato region	Rest of New Zealand
Employment	-0.01	0.29	-0.04
Real wage	0.08	0.38	0.06

Source: Principal Economics

4.2.4.3 Industry-level impacts

The industry-level result shows a reduction in road transport sector output. This change is because of more efficient transport networks, leading to fewer vehicle kilometres travelled (VKT) and, therefore, less income and production for the sector. However, the benefit of the expressway is positive in almost all other sectors, depending on where they are located. Nevertheless, for some industries, we can see a negative impact on the output (for example, wholesale on the South Island) because economic resources are moved to more profitable sectors/regions, especially in Waikato. In general, most industries benefit from the lower cost of trade in New

Zealand. For example, the tourism sector includes domestic tourism, export tourism, and foreign holidays. Time savings between home and destination will improve the tourism sector's overall output.

The reason for a smaller GDP of the road transport sector is the decrease in the cost of road transport, which leads to an overall smaller GDP for the sector. However, this leads to improved outcomes for the other sectors of the economy and, overall, a more productive economy.

²⁹ Technically, in the General Equilibrium analysis, any gains to labour take the form of higher wage rates, in contrast to Richard Paling Consulting's (2010) partial equilibrium, in which the gains manifest as higher employment – as shown in Section 3.2.

Table 7: Industry-level outputs

Unit: \$ million (2022 prices); annual.

	Auckland the upper North	Waikato region	Rest of New Zealand	Total (New Zealand)
Retail	13.0	17.3	2.8	33.1
Wholesale	20.7	9.5	-2.4	27.8
Horticulture	-3.5	34.0	-2.1	28.4
Dairy production	14.7	55.2	12.9	82.8
Mining	-2.4	37.4	-10.4	24.6
Other food and drinks	1.5	0.6	-1.5	0.6
Manufacturing	29.8	50.7	-18.4	62.1
Utilities	3.8	7.6	4.3	15.7
Construction	14.4	14.3	-1.5	27.2
Services	109.8	80.4	46.7	236.9
Road transport	-45.9	-43.4	-35.4	-124.7
Rail	0.4	0.4	0.2	1
Other transport	4.8	1.0	0.2	6
Education	1.0	3.4	2.5	6.9
Tourism	2.1	4.4	1.9	8.4

Source: Principal Economics

The industry-level employment shows improved employment outcomes for almost all sectors in Waikato. The most significant improvements are in the mining, horticulture, retail, rail and dairy production sectors. There are a range of negative impacts on the employment of

sectors in other regions, due to improved attractiveness of Waikato's job market, which leads to the migration of skilled labour to Waikato. The overall economic impact from this migration is positive for New Zealand because of improved allocative efficiencies.

Table 8: Industry-level employment

Unit: % change; annual.

	Auckland the upper North	Waikato region	Rest of New Zealand
Retail	0.03	0.51	-0.02
Wholesale	0.06	0.39	-0.06
Horticulture	-0.11	1.54	-0.05
Dairy production	0.14	0.48	0.02
Mining	-0.27	2.50	-0.23
Other food and drinks	-0.02	0.12	-0.04
Manufacturing	0.06	1.04	-0.09
Utilities	0.01	0.00	0.01
Construction	-0.01	0.17	-0.03
Services	0.01	0.24	-0.01
Road transport	-1.00	-3.65	-0.63
Rail	0.07	0.49	0.01
Other transport	-0.02	0.06	-0.03
Tourism	-0.04	0.09	-0.02

Source: Principal Economics

4.3 Total Forgone Economic Activity from IDM Delays

In Section 3.3 we presented a range of direct impacts, including economic and social, network performance, and sector-specific impacts. Our estimated benefits of \$281 m include the impacts from improved transport network transport and the impacts on different sectors of the economy, including tourism. In addition to these (downstream and upstream) benefits, we identified a total of \$53.35 m in annual benefits from improved road safety.

Accordingly, the total foregone benefits of one year delay in the Expressway is equal to \$334.4 m.³⁰

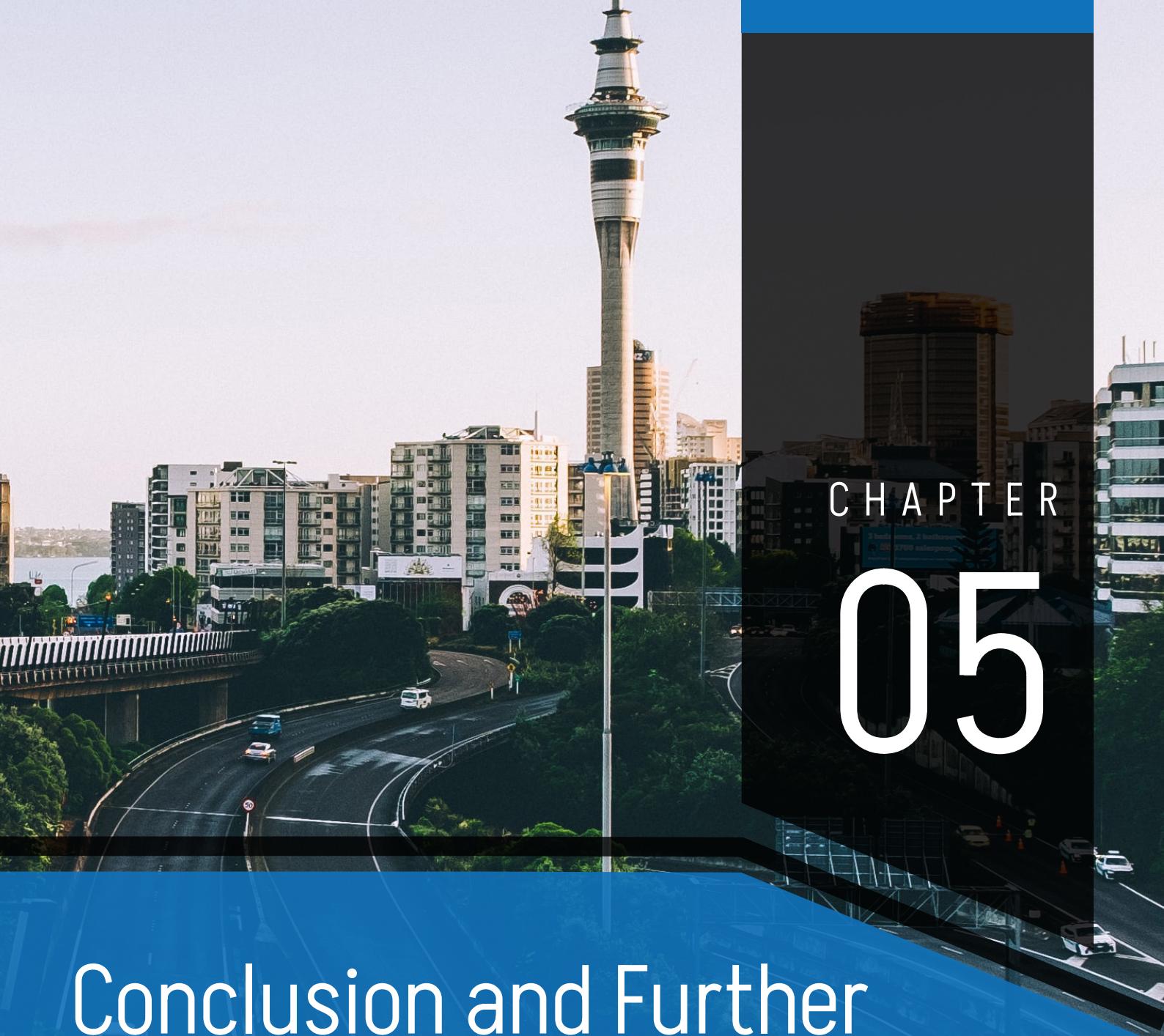
In Section 2.1 we suggested that there is a potential to reduce decision-making timeframe by 7 years (that is, a decrease in IDM time of 15 years to eight years).³¹ If we assume that the Waikato Expressway had been completed 7 years earlier, the New Zealand economy would have saved a total of \$2.3 billion (over 7 years). This implies that **the delays have led to a minimum forgone benefits of 1.2 times the total capital cost of the project** (which is approximately \$1.9 billion).³²

³⁰ We suggest that the estimated time-savings used as inputs into our model provide a conservative estimate of the benefits of the Expressway. The stakeholders suggested that the time savings could be twice as large as the estimated figures.

³¹ We suggested that, in the case of the Expressway, there was potentially a 40-year delay. Using the 15-to-8 ratio, the IDM delay for Expressway was potentially around 20 years.

³² We have observed some differences in the cost estimates, in different papers. Using Infometrics' (2010) estimate of capital cost, the total cost is \$1.86 billion in 2022 dollars.





CHAPTER 05

Conclusion and Further Discussion

• • •

New Zealand suffers from long delays between project planning and delivery. The Infrastructure New Zealand commissioned Principal Economics to provide an assessment of the economic impact of an efficient infrastructure investment process.

Inefficiencies in infrastructure decision making process leads to:

- overuse, congestion and eventually damped economic growth.
- forgone economic opportunities and household wellbeing.
- interrupted supply of infrastructure services driven by lack of sequencing, which leads to increased costs to service providers from labour turn-over and capital depreciation.

This report provides further discussion about the importance of efficient decision making and potential next steps, and provides an estimate of:

- The wider economic benefits (WEBs) from the cost efficiencies resulting from the improved decision process.³³ This includes the agglomeration benefits resulted from efficient collaboration of labour force within and between firms using the improved infrastructure, for example.
- The economy-wide benefits from improved efficiency using a better decision process. This includes the flow-on effects that account for the interactions between businesses, households, and the government.
- Wellbeing impacts to New Zealand communities.

While each infrastructure project is different, and require separate economic evaluation, our case study aims to provide a ballpark figure for the upstream and downstream costs associated with a slow infrastructure decision making process. To provide an estimate of the likely social cost of delays in infrastructure decision making, we used Waikato Expressway as the case study of this analysis.

We used our subregional CGE model to estimate the downstream benefits of the Expressway. We used our subregional CGE model to estimate the downstream benefits of the Expressway. Accordingly, the annual benefits of having the Expressway in the economy is equal to \$281 million. Accordingly, the annual benefits of having the Expressway in the economy is equal to \$281 million. In addition to that there are positive safety impacts of \$53.35 million. Hence, the total economic benefit of the Expressway is equal to \$334 million.

The planning timeframe in New Zealand is longer than Australia. There are a range of examples, that we have referred to in this report. Accordingly, we suggest that **there is a potential for significant time saving in the IDM's planning process, from the current 15 years to 8 years.**

If we assume that the Waikato Expressway would have been completed 7 years earlier, the New Zealand economy would have saved a total of \$2.3 billion. Compared to a total cost of almost \$1.9 billion, the IDM delays have led to

forgone benefits of 1.2 times the total capital cost of the Waikato Expressway.

Delays are caused by a range of uncertainties at the planning phase, including demographic and population, macroeconomic, technological, climate change, and political uncertainties. There are a range of regulatory changes and policy framework intending to address this costly issue. This includes the directions provided by the Infrastructure Strategy, Resource Management reform, and the NPS-UD 2020. Most importantly we suggest the following objectives have significant implications for the delays in the planning phase:

- To improve transparency through providing national direction, and inclusivity through local devolution
- To increase the quality of advice through careful considerations of scenarios and pathways, and by accounting for separation and sequencing of options

We further discuss the direction of policy frameworks and their impact in the next section.

5.1 The Direction of Policy Frameworks

In this section we refer to the most relevant policy frameworks. As discussed above, there is a need for improved investment decision making processes. The recent developments in the policy frameworks attempt to address some important issues to improve certainty, which leads to time savings in decision-making processes.

5.1.1 National Policy Statement on Urban Development (NPS-UD)

The NPS-UD 2020³⁴ provides guidelines for improving the competitiveness of urban land markets by increasing the responsiveness of development to local land price changes (MfE & HUD, 2020). A more *competitive land market* will reduce the monopoly power of landowners, increase competition between locations across a city and is expected to result in lower land values. To achieve this, the NPS-UD requires regional councils to undertake an analysis

³³ Wider economic effects are usually not directly captured in a typical economic impact framework and includes outcomes such as agglomeration benefits, tax revenues from labour markets, and changes in outputs in the imperfectly competitive markets.

³⁴ The National Policy Statement on Urban Development Capacity 2016 was replaced by the NPS-UD in 2020.

of demand and supply (housing capacity) by accounting for the availability of different types of infrastructure. This informs the Housing and Business Capacity Assessments of housing affordability and sufficiency. The findings from the assessment informs the urgency of changes in planning and infrastructure plans and ensures that the right infrastructure is provided in the right place at the right time, which provides adequate access to economic and social opportunities and enables people to maximise their wellbeing.

The NPS-UD requires local councils to provide sufficient feasible development capacity in resource management plans and support that with infrastructure.³⁵ The NPS-UD uses the Future Development Strategy (FDS) process to ensure that the planning processes provide enough development capacity to meet future growth needs. The objectives of the FDS are to:

- ¶ Improve the alignment between spatial planning and land-use and infrastructure planning³⁶
- ¶ Inform RMA plans and other relevant legislation
- ¶ Promote a well-functioning urban environment, informed by the values of iwi and hapū

The FDS tasks councils to provide information about the location of future development and timing of infrastructure investment. The objective of the FDS is to minimise infrastructure costs and prevent severe rises in house prices. To achieve this, the NPS-UD recommends developments in areas with high accessibility to jobs, urban amenities and transport technologies. This is consistent with the housing-specific objectives of the RM reforms to provide the right infrastructure, in the right place at the right time, that provides adequate access to economic and social opportunities and enables people to maximise their wellbeing.

5.1.2 Resource Management Act (1991) (RMA)

The RMA contains a number of specific environmental regulations that councils must implement. For example, Section 6 requires councils to recognise and provide for

“the protection of areas of significant indigenous vegetation and significant habitats of indigenous fauna”. In practice, this is done using “Significant Ecological Area” overlays that, once in place, restrict the range of development activities that can occur.

The RMA also provides a framework for the implementation of many of the planning regulations with potential dampening impacts on economic growth. However, it is not possible to determine which of these regulations are required by the RMA and which are simply the result of council decision-making.³⁷ Neither is distinguishing between those regulations that are motivated by environmental concerns and those that are intended to serve other purposes. The primary impact of the RMA is through land-use regulation, which affects urban growth boundaries (at the periphery of the city), and the resource consent's level of permission for different activities.

Urban boundaries offer one example. While the RMA does not explicitly require councils to impose urban boundaries, councils might argue that such boundaries are necessary to achieve the purpose of the Act, being the “sustainable management of natural and physical resources”. Whether urban boundaries are “environmental regulations” is also debatable. To the extent that they reduce transport emissions or the sealing over of peri-urban land, urban boundaries could be seen as environmental in nature. That said, councils have often chosen to impose urban boundaries for other reasons, such as minimising infrastructure expenditure (and operating costs of inefficient transport services).

The RM Reform will improve transparency, which improves consistency with objectives of the NPS-UD. However, it will take some time to see the benefits.

Resource Economics, Principal Economics and Sapere (2021) assessed the impact of the Government's proposed reform of the resource management (RM) system (RM reform). They discussed that the outcomes of councils' planning regulation (driven by the NPS-UD), if accompanied by a permissive and transparent RM system, can lead to improved housing market outcomes compared to those

³⁵ Providing feasibility analysis of urban development capacity is a requirement for high- and medium-growth local authorities.

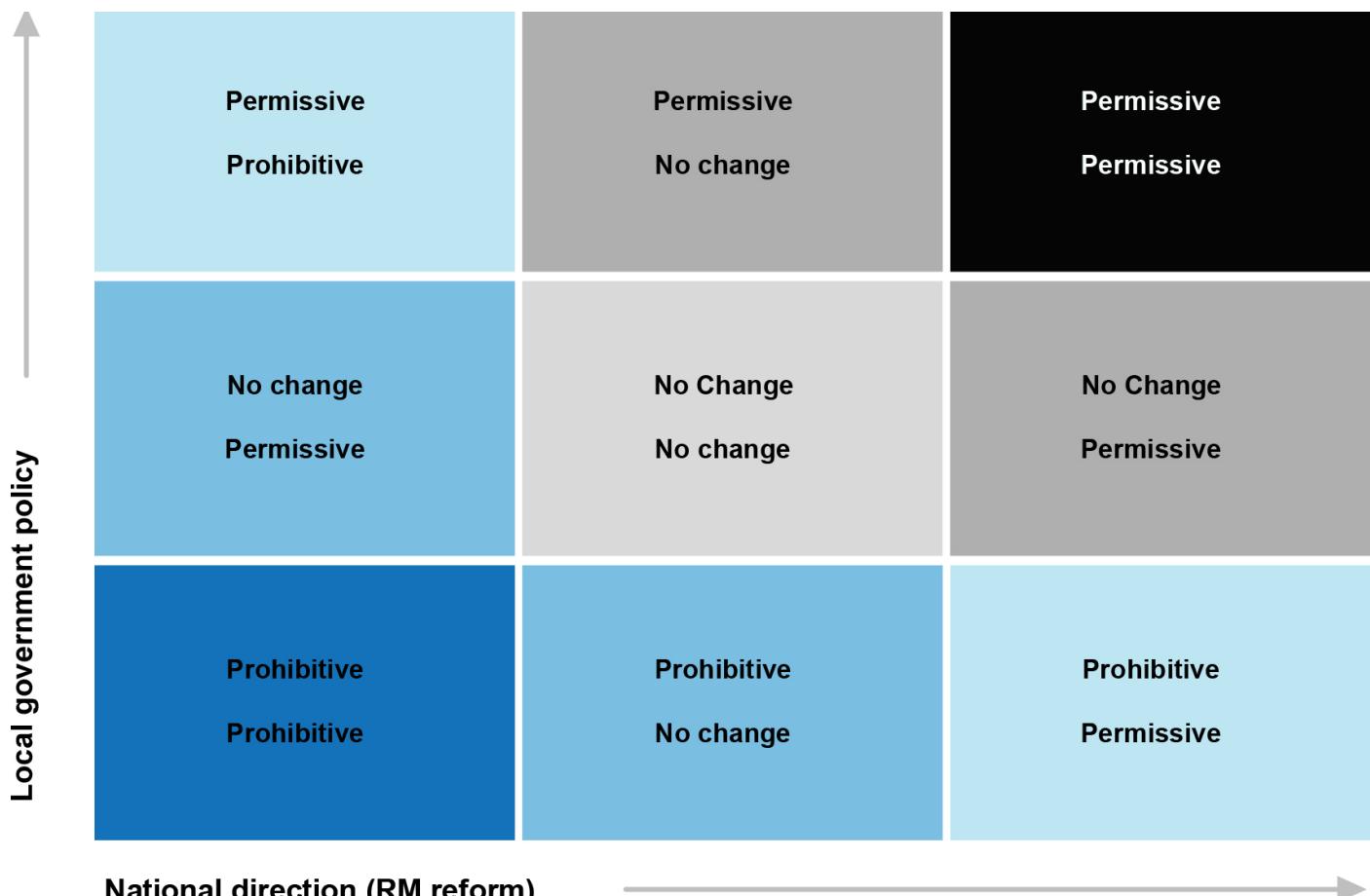
³⁶ This is consistent with previous reports calling for positioning higher density developments along existing transport infrastructure; see, for example, Brebner (2014).

³⁷ Zoning land is not a requirement of RMA, but it is a basic technique for controlling land use.

from the NPS-UD alone. As shown in [Figure 13](#), the combination of the features of the RM system and their

interactions with the councils' regulation may lead to a wide range of outcomes for the housing market.

[Figure 13: Combined impact of RM system and planning regime](#)



Source: *Principal Economics*

The NPS-UD and RM reforms are highly aligned in their objectives. The outcomes of councils' planning regulation (driven by the NPS-UD), if accompanied by a permissive and transparent RM system, can lead to higher benefits than those from the NPS-UD alone. The RM Reform objective is to improve system efficiency and effectiveness, and reduce complexity, while retaining appropriate local democratic input (New Zealand Government, 2021). To achieve this, a range of policy changes are proposed in the reforms, including:³⁸

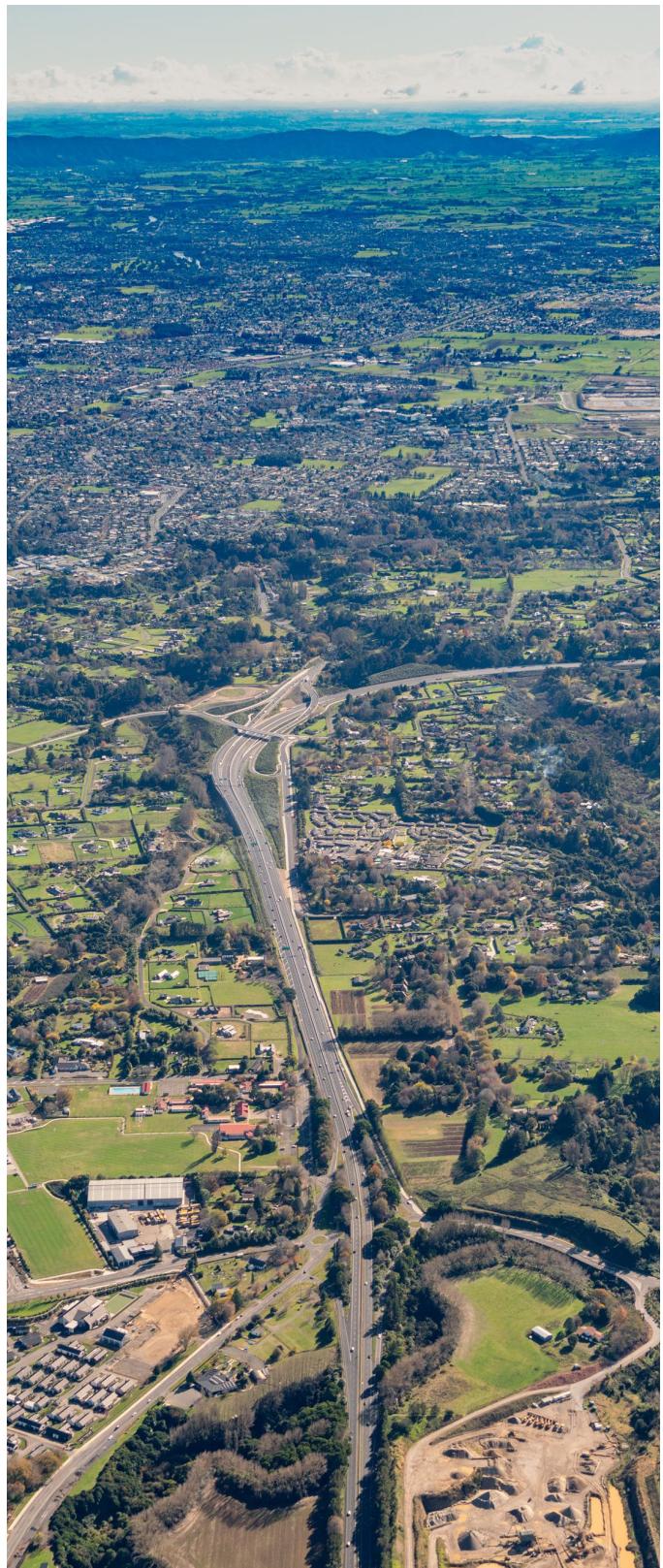
- Providing more national level direction to decrease the chance of negative externalities from one region's urban growth on other regions
- Decreasing the number of Acts to resolve any potential inconsistencies across different pieces of legislation leading to a higher certainty level

Based on New Zealand Government's (2021) proposed changes, the expected improvements from the RM reforms include:

³⁸ We only refer to the most relevant changes from the RM reforms. There are a wider range of changes, which will also lead to improved outcomes for the planning phase of the IDM.

- Greater use of **mandatory national direction** by the Minister for the Environment to guide local government. A **more certain regulatory framework** that will lead to higher certainty around zoning regulations.³⁹ The housing objectives of the RM reforms are consistent with the NPS-UD but will lead to a more substantial regulatory framework expected to produce structural changes to local governments' regulations (and regulatory power) and, ultimately, change the shape of New Zealand metropolitan and rural areas.
- Improvements to resource consents and consent processes, including:
 - Providing greater clarity about notification of consent applications
 - An alternative process to deal with consents for small, localised issues;
 - An improved ability to have more serious disputes over consents referred directly to the Environment Court
 - Improving the ability of regional councils to modify or extinguish resource consents where environmental limits are threatened; and
 - Enabling territorial authorities to change land use consents to implement a managed retreat process as part of adapting to climate change.
- **More flexible housing supply.** National direction is expected to be more focussed on permissive regulation, allowing more flexibility in housing supply. Furthermore, environmental limits are expected to result in more housing intensification. This is more significant in land-scarce regions, particularly Auckland. Given the long-term impact of RM reform, the other regions are likely to feel the impacts more significantly in the next decades.

The impacts of RM system and NPS-UD are complementary. The objectives of NPS-UD, which are based on the RMA, are similar to the objectives of the Government's proposed reform. This is shown in Table 9 based on the initial objectives indicated by New Zealand Government's (2021) proposed changes; that is, these are indicative at this stage.



39 Zoning land is not a requirement of RMA but it is a basic technique for controlling land use.

Table 9: High level housing and infrastructure outcomes of NPS-UD and the RM reform

Outcomes	NPS-UD & RMA	RM reform
Affordability	NPS-UD has a range of recommendations that contribute to housing supply elasticity, including: <ul style="list-style-type: none"> Intensification through more liberal planning constraints Development at scale Competitive land markets and high-quality greenfield development 	<ul style="list-style-type: none"> National direction and clearer legislation lead to decreases in consenting cost, which translates into allocative efficiencies Housing supply is responsive to demand, with competitive land markets enabling more efficient land use and responsive development, which helps improve housing supply
Choice	Improving housing choice through: <ul style="list-style-type: none"> Increasing planning flexibility Aiming for agglomeration benefits; that is, larger or denser places tend to provide a greater variety of services and consumer goods 	Increased housing supply to better meet residents' demand for housing (by type, size, location and price)
Māori participation	Recognise Te Tiriti and contain provisions aiming to enable Māori participation in the system	<ul style="list-style-type: none"> Enabling the housing aspirations of Māori such as by enabling papakāinga developments Providing opportunities for Māori to participate as Treaty partners across the RM system, including in national and regional strategic decisions. Māori will be sufficiently resourced for duties or functions that are in the public interest
Climate change	Better prepare for adapting to climate change and risks from natural hazards, and better mitigate emissions contributing to climate change	A reduction in transport carbon emissions versus the status quo from more efficient land use patterns through improved spatial planning
Improved System performance	Focused on improving effectiveness of planning regulations	Improve system efficiency and effectiveness, and reduce complexity, while retaining appropriate local democratic input

Source: Principal Economics based on Cabinet papers (MfE, 2021)

5.1.3 Direction of change and other relevant policy frameworks

The policy frameworks share a common target of achieving productivity, inclusivity and sustainability (New Zealand Government, 2020, p. 4). As discussed above, a range of recent policy documents are focused on addressing

important drivers of delays in infrastructure decisions. This approach will help to improve outcomes in the coming years.

Transparency through providing *national direction*, and inclusivity through *local devolution*

The RM reform includes a new national planning framework's (NPF), which will provide greater (mandatory) national direction. Consistent with the objectives of NPS-UD, the NPF will lead to improved prioritisation of national outcomes and better governance of potential negative externalities. National direction and more clear legislation leads to decreases in consenting cost, which translates into allocative efficiencies.

There has also been significant emphasis on impact of infrastructure decisions on communities. The objectives of the RM reforms are to improve system efficiency and effectiveness and reduce complexity. This leads to retaining appropriate local democratic input. There has been significant emphasis on the importance of equity issues in (housing and transport) infrastructure decisions. This is reflected in NPS-UD's requirements for local councils to decompose their capacity assessment for different population groups, and in the recent work of Waka Kotahi on equity impacts of infrastructure decisions. (Principal Economics, 2022)

Quality of advice leads to improved timing of infrastructure decisions through careful considerations of scenarios and pathways, and by accounting for separation and sequencing of options

As discussed, the investment frameworks guided by the Better Business Case (BBC) approach recommended by the Treasury provide a robust assessment framework for infrastructure projects. Different agencies have been working on identifying and providing guidelines for accurately addressing uncertainties in their investment frameworks. The outputs provide useful information for the planning phase, to ensure accelerating informed decision-making.

For example, Waka Kotahi's recent developments of the appropriate approach for capturing distributional impacts of transport investments provides useful information for addressing a range of political uncertainties raised from inter- and intra-general equity issues (Principal Economics 2022).

As discussed, uncertainties are an important reason for delays. We suggest that agencies need to consider a wider range of scenarios (scenario planning) and potential pathways within the strategic case, in the development of Programme Business Case and Single Stage Business Case (SSBC); for details, see Figure 3. These must then be accompanied by a robust economic evaluation (CBA). The consideration of a wider range of scenarios ensures flexibility to respond to different situations as they arise.

Currently, government agencies are in the process of developing their response to climate change, which is considered as a case of deep uncertainty.⁴⁰ For example, Principal Economics (in press) provided suggestions on how an adaptive decision-making (ADM) approach to climate change can be used for evaluating economic land transport activities in New Zealand and be incorporated into Waka Kotahi's Investment Decision Making Framework (IDMF). We suggest further consideration of different levels of uncertainty and Adaptive Decision Making in different policy frameworks to support flexibility in decision-making.

Te Waihanga – Infrastructure Commission's Strategy provides a comprehensive list of potential improvements in the decision-making process. (New Zealand Infrastructure Commission, 2022, pp. 183–190).

5.2 Limitations of Our Analysis

There are potential economic benefits that arise from interdependencies between closely related infrastructure projects. This is important in the context of this project because an IDM delay leads to delays in interdependent projects. Potential additional benefits will be generated by implementing a package of projects, or considering a programme instead of a project, which will be greater than the sum of the benefits of the individual projects in the package. In our meetings with the stakeholders, they referred to the importance of the interdependencies. We suggest further investigation of this in a future study.⁴¹

⁴⁰ Deep uncertainty occurs when decision-makers and stakeholders do not know or cannot agree on how likely different future scenarios are. Climate change is commonly mentioned as a source of deep uncertainty (Marchau, Walker, Bloemen, et al., 2019).

⁴¹ For further details on interdependencies, see Byett (2017).



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Appendices

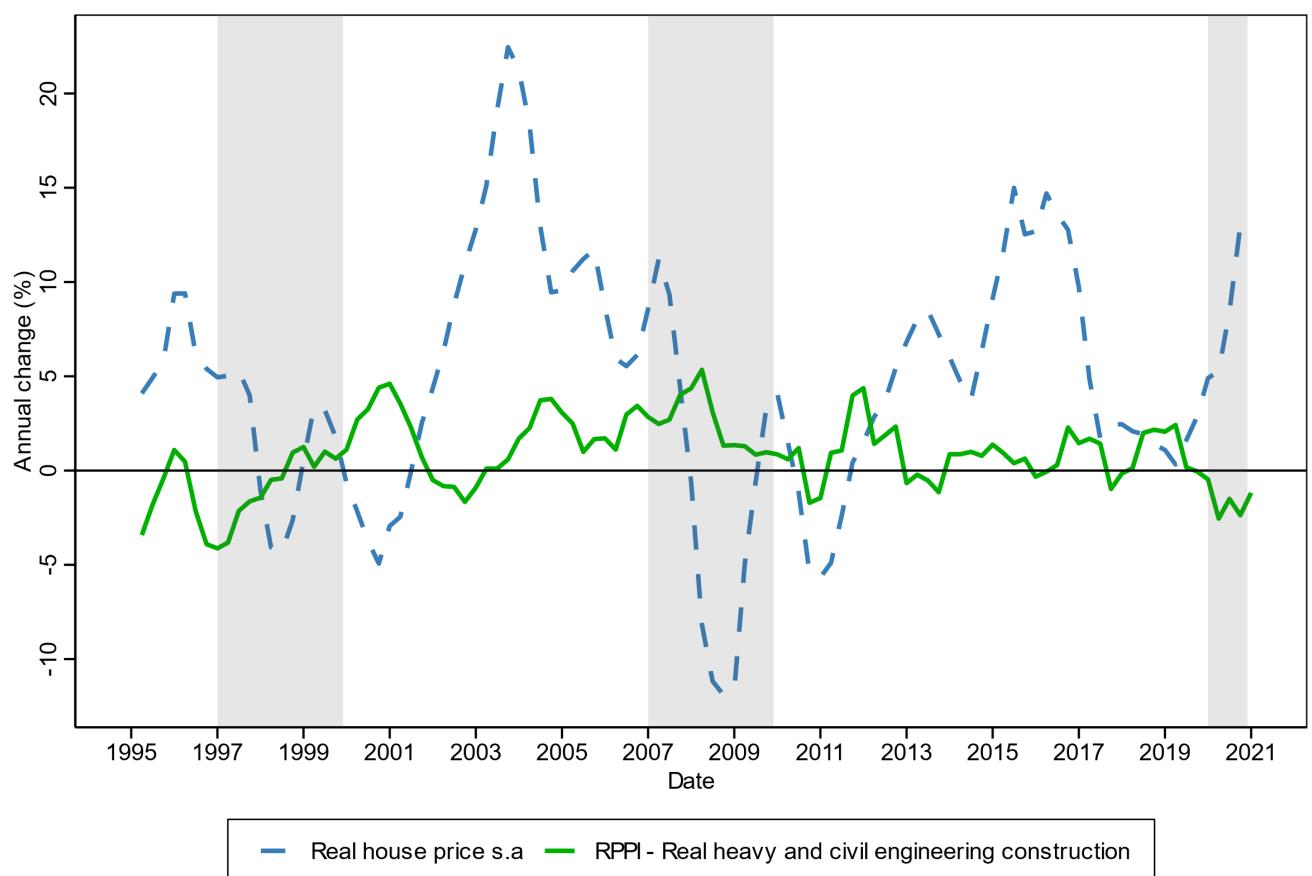
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Appendix A - The operating cost of the infrastructure sector over time

Figure 14 shows the changes in (real) Producers' Price Index Outputs for the 1995–2021 period.⁴² Accordingly, the operating costs of the infrastructure sector has increased gradually over the last two decades (between 2000 and 2020) by 22 percent

Figure 14: Real PPI – Heavy and civil engineering construction

% change, Real PPI – Heavy and civil engineering construction



Source: Bank for International Settlements, Statistics NZ, Principal Economics analysis

Note: We sourced the s.a. real property price index from The Bank of International Settlements, PPI for heavy and civil engineering construction from Statistics NZ and adjusted for inflation using the CPI from Statistics NZ. We then calculated the year-on-year annual change for each series. We highlight notable recessionary periods in New Zealand identified by Reddell et al. (2008). These include the First Oil Price Shock (1974–1977), the Second Oil Price Shock (1979–1982), the 91–92 Recession (attributable to the 1987 share market crash, subsequent monetary responses and impacts of the first Gulf War, 1991–1992), the Asian Crisis and drought (1997–1999), and we added COVID-19 as an additional recessionary period (2020–).

42 This index captures all costs of production except taxes and subsidies.

Appendix B - PE-CGE Model Description and Its Closure

Principal Economics' sub-regional CGE model (PE-CGE)

We used the static version of our advanced sub-regional CGE model of the NZ economy. Our model is developed in collaboration with the CoPS⁴³ (University of Victoria in Melbourne). Our database is calibrated with 2020 input output tables from Stats NZ, which is the latest available input-output table for New Zealand.

In PE-CGE, economic sectors are connected to households through the goods and services they provide, the wages that they pay and the labour input that they receive. The industries also provide goods and services to the government and receive services in return. The government and industries are financially connected through subsidies and taxes. The rest of the relationships across industries, households, government, and financial sector for one subregion in the model are illustrated in the figure. We have 81 subregions in the model, representing territorial authority geographic definition (and for Auckland we have further disaggregation). Each subregion has similar relationships across the sectors of their economies. This is the highest level of disaggregation of regional and industrial relationships available in New Zealand. All the regions are connected to the global economy, through trade, capital markets and labour force. The capital outputs of trade flow to the economy of all the sectors of the economy through the finance market. For technical reasons, we often aggregate the database to run the model. Therefore, although details of all regions/industries are not presented in the results, they have been used as input to our model.

Our CGE model captures all economic interactions in the New Zealand economy, including trade and spending between firms on one another's goods and inputs; spending by consumers on goods; investment decisions; and dynamics in the market such as demand for factors such as capital and labour, trade, employment and wage effects.

The outputs of our CGE model will provide regional and national level estimates of GDP, employment, industry outputs and import/export, and households' economic wellbeing.

Closures

In any economic model, we must choose what is to be determined within the model (the endogenous variables) and what is to be considered external to the model (the exogenous variables); that is, we are 'setting up closures'. The process of drawing this line depends on model tractability and the purpose for which the model is to be used. We use a long-term closure for this study because trade impacts happen over time, and it takes time for the economy to adjust to use new lower trade costs and to benefit from that. For example, workers should have enough time to see higher wages in other regions to decide to move, and hence labour movement does not happen in the short-term closure.

We assume a long-run model closure in which the following assumptions are made:

- Labour market closure: total national employment is fixed but perfectly mobile across industries and/or regions as workers look for better opportunities (expressed in terms of real wages). Therefore, the real wage adjusts.
- Capital market closure: capital stocks adjust to maintain fixed rates of return. We assume that capital is mobile between industries and regions.
- External closure: The balance of payments is a fixed proportion of nominal GDP. The real exchange rate is endogenous. So, negative shocks to the economy are not funded by borrowing from overseas.
- Fixed investment/capital ratios. In other words, the percentage changes in capital and investment are equal in the long term. Therefore, investment is equal in all sectors/regions following the capital stock.

Other fixed elements of our model are land use, import prices, number of households, taxes production, national labour supply, technological change, foreign demand for NZ products, growth rate of return of capital, and national population.

Appendix C – Waikato Expressway – Estimated Costs Over Time

Table 10: Regional employment and wages

Unit: \$ millions nominal.

Section	Completed	Estimated project cost					Estimated construction cost	
		2002	2006	2011/12	2014	2018	2021	2022
Mercer	July 2006	74.5	82.0	-	-	-		
Longswamp and Rangiriri	December 2020	33.0	55.7	117.0	70.0	96.0	92.0	92.0
		26.0	26.0		105.0	131.0	123.0	123.0
Huntly	February 2020	100.0	200.0	579.0	470.0	409.0	383.0	383.0
Ngāruawāhia	December 2013	50.0	200.0	248.0	190.0	160.0	166.0	166.0
Te Rapa	December 2013	-	-	194.0	195.0	172.0	172.0	172.0
Hamilton	TBC	130.0	280.0	890.0	790.0	637.0	837.0	837.0
Cambridge	December 2015	39.0	70.0	204.0	230.0	218.0	182.0	182.0
<i>Source:</i>		<i>Transit NZ</i>		<i>Waka Kotahi NZ Transport Authority</i>				

Source: Principal Economics, Transit NZ, Waka Kotahi NZ Transport Authority

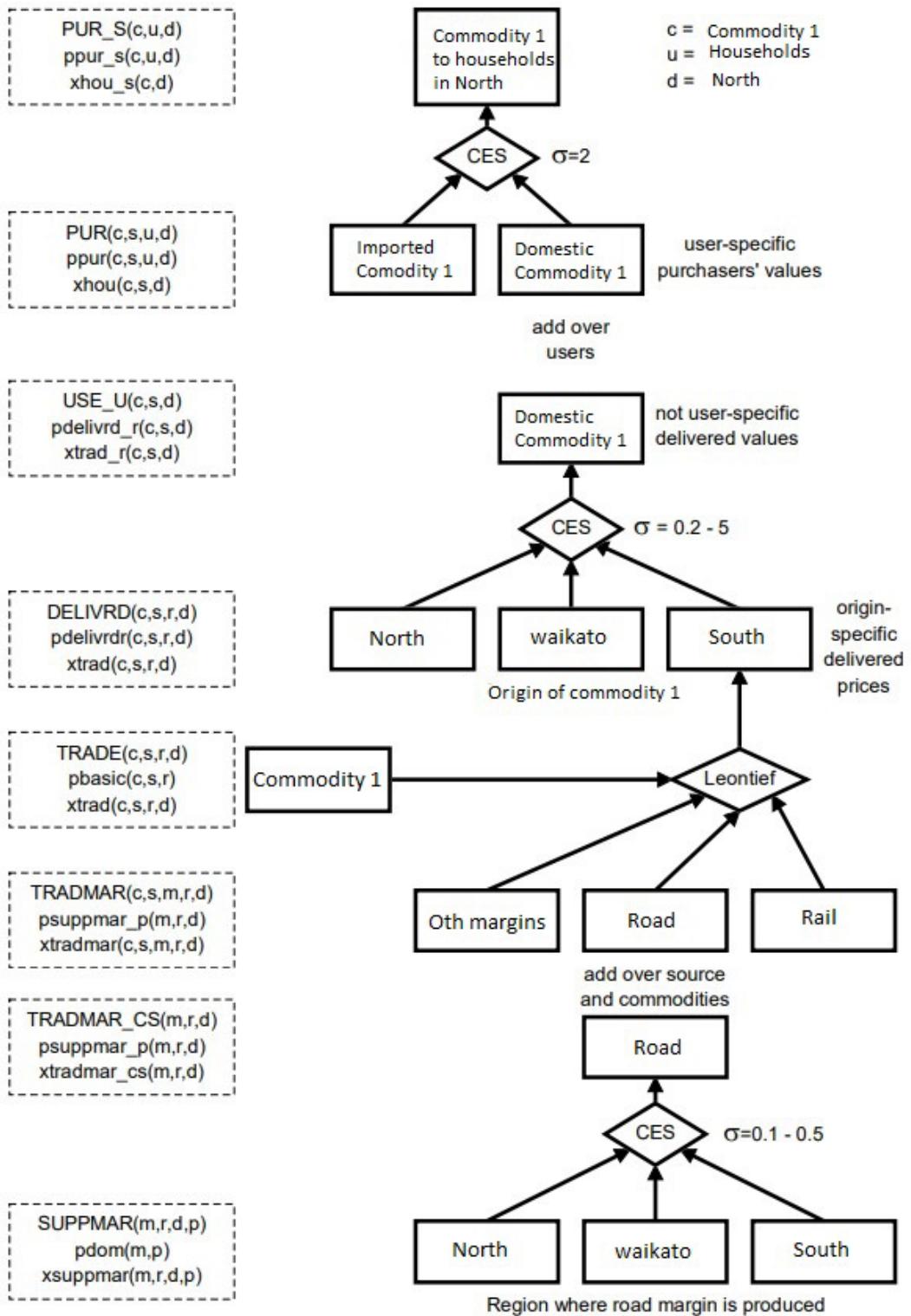
Note: Target completion dates are sourced from a snapshots of the Transit NZ and Waka Kotahi NZ Transport Authority websites during the years shows in Table 6. Completion have been sourced from Beehive and Waka Kotahi NZ Transport Authority media releases and project overviews. Where a range has been given for estimated project cost we have used the higher of the two values.

Appendix D – Sourcing Mechanism in the PE-CGE Model

The following equations and diagram show a series of nests indicating the various substitution possibilities allowed by the PE-CGE model to represent the inter-regional trade structure. We used the trade margin technological change variable to show the impact of improvements in road transport margin on the economy. Figure 15 shows the sourcing mechanism of PE-CGE's database.

Equation (1):	$XTRADMAR(c,s,m,r,d) = ATRADMAR(c,s,m,r,d) * XTRAD(c,s,r,d)$
Equation (2):	$PDELIVRD(c,s,r,d) * XTRAD(c,s,r,d) = PBASIC(c,s,r) * XTRAD(c,s,r,d) + \text{sum}\{m, MAR, PSUPPMAR_P(m,r,d)\} * XTRADMAR(c,s,m,r,d)\}$
$ATRADMAR(c,s,m,r,d)$	Trade for margins technological change
$XTRAD(c,s,r,d)$	Quantity of good c,s from r to d
$XTRADMAR(c,s,m,r,d)$	Margin m on good c,s going from r to d
$PBASIC(c,s,r)$	Basic prices
$PDELIVRD(c,s,r,d)$	All-user delivered price of good c,s from r to d
$XSUPPMAR_P(m,r,d)$	Quantity of composite margin m on goods from r to d
$PSUPPMAR_P(m,r,d)$	Price of composite margin m on goods from r to d

Figure 15: The sourcing mechanism of PE-CGE's database



Source: Horridge and Pearson (2011); Principal Economics



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