



9 June 2022

# Economics Technical Report: Strategic CBA Review

Sensitivities and Critical Considerations for Programme Benefit Cost  
Analysis

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## Document Acceptance

Action	Name	Signed	Date
Prepared by	Transformational Programme Team		
Reviewed by	Andrew Bowman		
Approved by	Adam Nicholls		
On behalf of			

## 1 Executive Summary

EY has been asked to provide a strategic review of Cost Benefit Analysis methodology within the Let's Get Wellington Moving Programme, exploring the breadth and relevance of economic assessment completed to date, as well as identifying opportunities to refine option analysis within the next stage of investment decision making. This Technical Report also includes sensitivity analysis intended to complement the uncertainties and risks considered within the *Preferred Programme Options Report*.

Our conversations with the wider LGWM team and review of CBA documentation indicates that **an appropriate and proportionate range of costs and benefits** have been modelled for the purposes of IBC development. The Programme team have clearly recognised the challenge of modelling and forecasting regional transformation and scoped their analytical workstreams accordingly.

A small number of analytical gaps have been identified by the joint MRT/SHI consultant team, for example a focus on traditional transport benefits and the application of an exogenous land use scenario (see section 4.2). We do not consider any of these issues serious enough to constitute an error or material deficiency in analysis at IBC stage. All four issues have been well communicated to Programme decision makers through the *Programme Short List Options Report, October 2021* and *Preferred Option Report – Modelling Appendix* reports.

We have identified a number of opportunities to refine Programme analysis at the Detailed Business Case (DBC) stage, ensuring that final options appraisal results are an accurate representation of viability and relative efficiency. We recommend that DBC planning include the following activities:

1. Dedicated population and Do Minimum modelling well ahead of DBC drafting
2. Alternative air pollutants and GHG scenarios, in line with contemporary Waka Kotahi guidance
3. Calculate returns to Government (BCR-Gs) in addition to standard national benefit calculations (BCR-Ns)
4. Review and agree an appropriate scope for the analysis of Wider Economic Benefits
5. Agree an approach to estimating, collating and communicating the uncertainty associated with option assessment results

Whilst the *LGWM Programme Preferred Option Report* recommends a preferred Programme option, the full case for investment in the MRT and SHI elements of the programme will be provided in a final IBC, which is due to be completed by the end of 2022. The key next for LGWM options analysis will therefore involve fully document the case for investment across MRT and SHI projects, detailing a final assessment process and proposing how future work could be delivered.

## 2 Introduction and Scope

This review has been commissioned to identify and explore key analytical issues within the Let's Get Wellington Moving (LGWM) Programme (the Programme). Specifically, EY has been tasked with reviewing the scope and methodology of Cost Benefit Analysis (CBA), as applied to the Indicative Business Case (IBC) stage of the Programme. It has been completed in the span of 6 weeks over the course of March – April 2022.

We note that the review is explicitly targeted at a conceptual and strategic level. EY has not examined the technical implementation of any modelling tools, for example the accuracy of spreadsheet formulae or source code. Findings and recommendations are based on methodological guidance information provided by the joint MRT/SHI consultant team, presentations developed by the Programme Technical Advisory Group, draft IBC documentation, the Programme Affordability Short List Option (PASLO) work and conversation with experts within Stantec and the LGWM joint initiative.

The review also includes a small volume of sensitivity analysis performed by EY, where direct testing was the most efficient way to address questions of uncertainty, sensitivity and materiality (see Section 0). This analysis is based on outputs provided by joint MRT/SHI consultant team. We understand that these organisations have robust quality assurance processes in place to avoid technical errors, so EY has not attempted to replicate this exercise.

Core to this review was a pragmatic and proportionate approach to critique. We recognise, for example, that the 'perfect' CBA model does not exist, and expanding the depth or complexity of assessment is not always desirable. Particularly in the case of dynamic or intangible benefits, the most appropriate model scope will often be a matter of professional judgement. Analysis beyond a certain point will sometimes represent a poor use of limited Programme resources, for example if results will be irrelevant or immaterial in differentiating options.

Equally important to our evaluation was the purpose of LGWM analysis as of April 2022, and the expectations for Indicative Business Case (IBC) options assessment set out in published government guidance. A different set of evaluation criteria would have been applied if LGWM had recently completed a Strategic Assessment or Detailed Business Case (DBC).

In addition to findings provided by a standard review, a significant part of this document proposes and explains tools that could be used to refine LGWM analysis at the DBC stage. Such key considerations and sensitivities include a dynamic Do Minimum option (recognising that the 'counterfactual' scenario can directly influence the economic viability of 'do something options'), quantifying wider economic benefits and carefully considering underlying population growth forecasts. Both low-effort and longer-term recommendations are provided, split into Sections 7 and 0.

In performing this review we have sought to answer six questions:

1. **Standard procedures:** Have good-practice costs and benefits been considered and assessed by the Programme team? (I.e. those that would be expected of any transport-sector Programme?)
2. **Strategic alignment:** Are the unique strategic objectives of the LGWM Programme adequately reflected in the scope of CBA modelling?
3. **Recognising uncertainty:** Have significant sources of variation and risk been identified and communicated to decision-makers?
4. **Modelling approach:** Are CBA design choices and assumptions aligned with published Government guidance? (For example, the Waka Kotahi Monetised Costs and Benefits Manual)

5. **Fit-for-purpose:** Is the analysis sufficient to provide decision-makers with the evidence necessary to make an informed decision?
6. **Next steps:** Has IBC analysis laid the groundwork for a successful and appropriate DBC?

As noted above, our answer to Question 6 includes a number of suggestions as to how LGWM modelling could be refined or expanded in future. We note that such recommendations are specific to DBC options appraisal, and are entirely distinct from our commentary on IBC analysis.

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### 3 Context and Role of CBA

As described above, this Technical Report focuses on analytical issues that are both **appropriate to an Indicative Business Case (IBC)** process, and could have a **meaningful impact** on option assessment results. Considerations that meet these criteria represent important sources of evidence for LGWM decision making in 2022. This Section is intended to clarify what this scope looks like in practice and the justification for its application at this point in PGWM Programme development.

#### 3.1 Indicative Business Case Expectations

IBC documents provide decision-makers with an early indication of the preferred way forward, ahead of formal recommendations being developed.<sup>1</sup> A successful IBC document should answer two fundamental questions:

- i Is there an issue or opportunity that is clearly worth investigating?
- ii Is there an approach or number of approaches to this issue that would lead to demonstrably different outcome to our current way of doing things?

Optioneering within an IBC does not consider an optimised Programme that is ready for implementation, and the Economic Case does not provide a definitive view on the best way forward. Rather, an IBC should articulate the rationale for an undertaking and support an in-depth options assessment exercise for the Detailed Business Case phase.

This approach was recently endorsed by Te Waihanga / NZ Infrastructure Commission and the Treasury in a review of New Zealand's Better Business Case Guidance, which is consistent with Waka Kotahi's approach to business cases in the transport sector. The review highlighted an inadequate separation of analytical scope between IBCs and DBCs to date – with the fault lying in IBCs failing to answer the core questions at the right level. This has led to poor value for money and negative implications for delivery timeframes.

#### 3.2 Material impacts and uncertainties

Complementing the purpose of analysis within an IBC, this Technical Report explores economic factors that could have a material impact on Programme decision making, and should be considered for LGWM analysis at DBC stage. There are a significantly greater number of areas that might have a small influence on costs and benefits and may be of academic interest. These have been excluded from this analysis for reasons of proportionality and focus.

Material impacts and uncertainties can primarily influence Programme recommendations in two ways: Altering whether a proposal represents **value for money** (sometimes characterised as economic viability, requiring a Benefit Cost Ratio of at least 1), as well as the **relative value** of Programme options (providing more nuanced differentiation for the purpose of selecting a preferred option).

We note that the majority of impacts explored within this Technical Report are monetisable, in the sense of being recognised by published guidance (e.g. Waka Kotahi's Monetised Costs and Benefits manual or similar). They have not been calculated at the IBC stage because their calculation requires bespoke analysis that is of a scope and magnitude that it is best quantified once detailed design at the DBC stage has decreased programme uncertainty and risk. The identification of these benefits at IBC stage is intended to provide confidence that a range of benefits commensurate with the scale of the programme have been identified conceptually, those able to be calculated at IBC stage have been considered, and those most appropriately considered at DBC stage will be assessed if the programme advances.

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<sup>1</sup><https://www.treasury.govt.nz/information-and-services/state-sector-leadership/investment-management/better-business-cases/guidance>

### 3.3 Why Benefit Cost Ratios Matter

Traditionally, BCRs are a quantitative measure of Programme / project viability, from the perspective of net economic value.<sup>2</sup> A standard BCR is calculated by dividing total benefits by total costs, with all inputs in real, discounted dollars, net of the Do Minimum.

A BCR of 1 means that the monetisable benefits of an option are equal to its monetisable costs. A BCR greater than 1 is commonly perceived as a necessary condition for an option to represent value for money. In contrast, a BCR of less than 1 means that an option is expected to incur costs in excess of its benefits. It is difficult to justify government expenditure in this case, absent other forms of evidence.

BCRs have a second, and equally critical purpose; namely they provide a standardised, rules-based approach to evaluating the differences between options. BCRs are often used as measures of relative economic efficiency, identifying where the government can expect to receive the greatest return on investment. BCRs, in this respect, arguably offer the fairest, most balanced single equation for comparing options for government intervention.

There are, however, a number of issues with relying on BCRs as the sole determinant of Programme viability and efficiency (discussed in more detail within Section 0). To ensure decision makers understand the pros and cons of alternative options, it is good practice to combine this type of CBA output with:

- Qualitative (or non-monetised) analysis, particularly focusing on costs and benefits that cannot be accurately measured in dollar terms. Such analysis can take the form of a Multi Criteria Analysis (MCA) exercise, or take the form of narrative assessment, summarised within an Appraisal Summary Table (AST).
- Assessments of strategic alignment, for example consistency with the Government Policy Statement on Land Transport. A Programme that offers very large journey time improvements alongside increased deaths and serious injuries, disincentivises the use of public transport and significant growth in greenhouse gas emissions may enjoy monetised benefits in excess of monetised costs. Presenting decision-makers with a BCR, isolated from strategic context and contextual information, would be highly misleading in this instance.
- Financial and commercial analysis, noting this can often give very different results from CBA modelling. A Programme with very large upfront capital costs may be unaffordable, based on available funding streams, such that its BCR is irrelevant. Similarly, an assessment of potential contractor capability may identify that an option introduces high levels of legal and commercial risk to the government. This option is unlikely to represent an optimal choice, even if it has the highest BCR.

The next section of this Technical Report provides an overview of LGWM CBA analysis completed to date, including modelling assumptions and preliminary results. This is followed by commentary on the quality of IBC modelling overall, answering the six strategic-level review questions described in Section 2 above.

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<sup>2</sup> Note that economic viability and financial viability are different concepts. The former questions whether an investment represents a prudent and worthwhile use of public funds, whereas the later tests affordability through an examination of available funding streams

## 4 CBA Approach and Preliminary Results

The Programme has undertaken economic evaluation of the shortlist options through a Cost Benefit Analysis (CBA). The CBA follows the recommended approach prescribed in Waka Kotahi's Monetised Benefits and Costs Manual (MBCM). It is a tool to support decision-makers and is widely used in the appraisal of public infrastructure projects to assess the total benefits generated for society by government investment, relative to the costs incurred to society in generating those benefits.

Economic benefits were estimated based on each option's modelled impact on Wellington's transport system, including the extent of mode-switching from the road network to public and active transport, reduced environmental impacts, and health benefits. These benefits were compared to the economic costs of delivering each option. The economic evaluation to-date focuses only on transport benefits and does not consider broader benefits that LGWM could deliver, such as benefits from improved urban form, climate change and social benefits. The Programme expects the benefit-cost ratios could rise further once these additional benefits and the nuance between options have been considered (i.e. applying a 'value engineering' process). Given these limitations, the Programme considers the results presented herein as **preliminary** only and subject to further refinement after a preferred option has been selected.

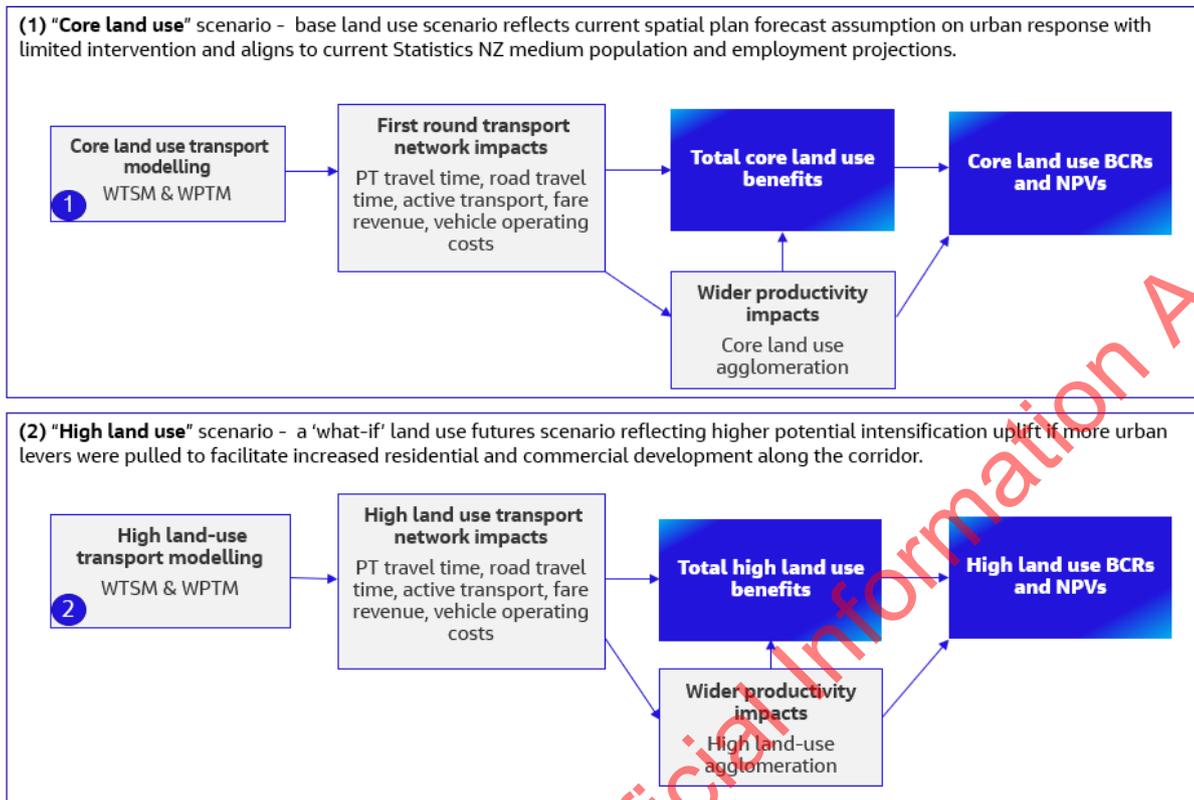
A preliminary CBA has been undertaken on Options 1, 2 and 4 to support this preferred option report. This relies on the multiple rounds of transport modelling and economic evaluation undertaken since the Programme Business Case in 2019 and the through the development of the IBC. With this body of existing evidence, full transport model runs were not performed on all options, with the focus for additional modelling work focusing on the 'bookend' options 1 and 4. Option 3 was not progressed to formal economic evaluation through CBA. As Programme transport modelling results have, in general, been aligned with the findings of MCA assessment, we have no reason to believe that an economic evaluation of Option 3 would identify material benefits over Options 1, 2 and 4. Similarly, as the cost of Option 3 is not significantly lower, it is unlikely to exceed the BCR range for Option 1. Each option has a wide range of possible urban outcomes, depending on the level of ambition and the supporting measures used to drive greater urban intensification.

An assessment of the potential urban uplift for each option was undertaken. Two scenarios were used to undertake the analysis – a 'core land use' and 'higher land use' scenario. The 'core land use' scenario reflects the current spatial plan forecast assumption on urban response with limited intervention<sup>3</sup>, whereas the 'higher land use' scenario relate to a 'what-if' scenario of potential intensification uplift if more urban levers were pulled to facilitate increased development along the corridor. An overview of the approach is illustrated in Figure 4-1 below.

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<sup>3</sup> Core land use assumptions developed in 2019 based upon updates to projections undertaken by .ID, in collaboration with the local Territorial Authorities. Core land use assumptions aligned to current Statistics NZ medium projections.

**Figure 4-1: Economic appraisal approach**



The Wellington Transport Strategic Model (WTSM) and Wellington Public Transport Model (WPTM) prepared by the Wellington Analytics Unit (WAU), were used to estimate transport impacts, with the models being able to output economic appraisal related measures which allowed for the monetisation of benefits. The tools have different strengths and weaknesses and have been used appropriately for the analysis associated with the IBC – depending on the issue being assessed and the level of detail required. Transport modelling outputs were processed in an interactive mapping tool to sense-check the spatial distribution of the outputs and identify any unintuitive results which could skew or bias the CBA.

The economic benefits appraised to date can be broken down into the following components:

- Public transport user benefits: including travel time savings (reduced in-vehicle time (IVT), access/egress time and wait times), and transfer penalties (the perceived travel costs incurred by public transport users who are required to change within modes (e.g., bus to bus) or between modes).
- Road user benefits: including travel time savings, savings in vehicle operating costs (VOCs), and improved road safety.
- Active mode user benefits: incremental benefits from making walking and cycling more attractive.
- Non-user benefits: including environmental benefits (emissions reductions) and incremental net fare revenue.
- Wider economic benefits (WEBs): including agglomeration.

#### 4.1 Key appraisal assumptions and inputs

Table Table 4-1 below outlines the key parameters and assumptions that are adopted throughout the preliminary CBA modelling. Further parameters and assumptions for benefit calculations can be found in 'Let's Get Wellington Moving - Draft Programme Report for Public Engagement'.

**Table 4-1: General parameters and assumptions**

Parameter	Assumption	Source
Real discount rate	4% per annum	Waka Kotahi (August 2021) MBCM
Base year for discounting	FY21	Assumption
Project opening year	FY31	Assumption based on potential phased completion of early LGWM programme components
Appraisal period	40 years of operation; final year of benefits is FY71	Waka Kotahi (August 2021) MBCM
Transport model years	2036 and 2046	WTSM and WPTM outputs
Linear interpolation	Benefits are estimated based on strategic transport modelling outputs for modelled years 2036 and 2046. Between these years, linear interpolation is used to estimate benefits on an annual basis.	Assumption
Extrapolation growth rate	The final modelled year for strategic transport modelling outputs is 2046 (mapped to financial year FY47 for benefit cashflows). Between this point and the final year of the appraisal period (FY70) benefits are extrapolated at a rate of 1% per annum.	Assumption
Benefits prior to first modelled year	The first modelled year for strategic transport modelling outputs is 2036 (mapped to financial year FY37 for benefit cashflows). For years between the first year of benefits (FY31) and the first modelled year (FY37), benefit cashflows are estimated by decaying the linear interpolation rate between FY37 and FY47.	Assumption. Consistent with interpolation of benefits between the modelled years
Inflation / escalation	Unit resource values for benefit and cost calculations are sourced from a range of publications and guidelines published at different points in time, quoting unit values in different prices. All unit values are escalated to March 2021 dollars using quarterly price indexes sourced from Statistics New Zealand. All future cash flows in the detailed CBA are expressed in real 2021 dollars, with no inflation or escalation applied.	Statistics New Zealand: Labour Cost Index (LCI) All Sectors Combined, All Salary and Wage Rates – for all values of time other than freight Producers

Parameter	Assumption	Source																
		Price Index (PPI) Outputs: Road Transport – for freight value of time Consumers Price Index (CPI) All Groups for New Zealand – all other parameters																
Rule of half	The 'rule of half' is applied when quantifying changes to consumer surplus for new or induced users of the transport network. The rule of half states that, on average, the change in consumer surplus to new and induced users is one half the change in consumer surplus to existing users of the network. The basis for this approximation is that the first new or induced user will realise the full extent of the improvement in the transport network, while the last new or induced user will realise only a negligible benefit, based on each user's perceived cost of travel. This approximation reflects an assumption that the demand curve for the transport network is linear. The rule of half does not apply to the estimation of resource corrections and externalities which are not included in users' perceived cost of travel.	Transport and Infrastructure Council, Australian Transport Assessment and Planning (ATAP) Guidelines: T2 Cost Benefit Analysis, May 2018, p. 32																
Expansion factors	The strategic transport modelling outputs are provided for three partial periods of the day: AM peak (AM) Inter-peak (IP) PM peak (PM). To estimate annual outcomes, transport demand must be expanded from (1) partial periods of the day to a full 24-hour period on an average weekday; and then (2) from an average weekday to a full year. The following expansion factors were applied: <table border="1" data-bbox="347 1429 1150 1574"> <thead> <tr> <th>Model Period</th> <th>PT</th> <th>Car</th> <th>HCV</th> </tr> </thead> <tbody> <tr> <td>AM</td> <td>406</td> <td>368</td> <td>368</td> </tr> <tr> <td>IP</td> <td>1,853</td> <td>2,169</td> <td>1,658</td> </tr> <tr> <td>PM</td> <td>406</td> <td>245</td> <td>245</td> </tr> </tbody> </table>	Model Period	PT	Car	HCV	AM	406	368	368	IP	1,853	2,169	1,658	PM	406	245	245	Wellington Analytics Unit (within GWRC)
Model Period	PT	Car	HCV															
AM	406	368	368															
IP	1,853	2,169	1,658															
PM	406	245	245															
Construction period	FY21 to FY34	Based on capital cost estimates and programme phasing assumptions																
Programme investment costs	Programme costs include phased capital investment, on-going operating and renewal costs, alongside lost parking income and the cost of financing. The costs are built up from work package and project information, which are a work in progress, subject to change, and will continue to be refined and updated.  P50 cost estimates are considered appropriate to adopt for the purposes of the economic evaluation. P50 cost estimates	The forecast costs of each option were estimated by the Programme and incorporated into the CBA model																

Parameter	Assumption	Source
	refer to a confidence level of 50% regarding the probability of the cost not being exceeded and adopt a set of assumptions around cost contingency.	

#### 4.2 Land use scenarios

As detailed in the Preferred Programme Options Report, a key consideration of a transformational programme of this nature is how it responds to, and catalyses, changes in land use. A successful programme will enable changes in land use patterns, urban form, and urban amenity relative to a situation where no programme is implemented (described below as a “do minimum” scenario).

A range of land use scenarios have been developed by LGWM that consider the nature and location of future growth. For the purposes of the analysis, all future year scenarios have assumed the same total quantum of growth across the Wellington region but have adjusted the distribution of future growth using a sliding scale between dispersed growth across the region and intensified growth along the MRT corridor.

Sensitivity tests show that Option 1 delivers significantly more benefits than options 2 and 4 under the intensified land use scenario. We understand, however, that the options 2 and 4 assessments are not directly comparable to the option 1 assessment. The option 2 analysis reported here has been developed based on an assumption that the assumed BRT option has less capacity to stimulate growth than the LRT based options – 20% less intensification has been assumed. The assessment undertaken for option 4 has assumed that the level of intensification assumed for option 1 to the south is achievable in this option. More detail on these assumptions is contained within the *Preferred Programme Options Report*.

We recognise that the assumption regarding total growth across the region is a simplification and ignores the very realistic potential for the transformational programme to deliver additional growth in the Wellington region because of the investment, which will be investigated further at the DBC stage.

#### 4.3 Transport model runs and inputs to economics

The LGWM Programme Team have undertaken multiple rounds of transport modelling and economic evaluation using outputs from WTSM and WPTM since the Programme Business Case in 2019 and since through the development of the IBC in 2020 and 2021. This large body of evidence provides us with sufficiently detailed information about the how notable transport interventions affects transport network and generates economic benefits for the programme. For this reason, full transport model runs were not performed on all options and instead model runs were undertaken on selected ‘bookend’ options to reflect the recent strategic transport improvements.

Improved representation of Option 1 and 4 were prioritised for full transport model runs for both modelled years as these were identified as suitable ‘bookends’ of the shortlist options for analysis to demonstrate the corresponding programme benefits. Consequently, transport network impacts and total benefits for Option 2 are inferred using results from Option 1 and previous model runs undertaken to support the public engagement and consultation material. This is considered reasonable as the transport network impacts of the Option 2 are similar in direction and magnitude to those of Option 1, with the exception of the selected mass rapid transit mode.

**Table 4-2: Economic analysis inputs**

Options	Core Land Use Scenario	High Land Use Scenario	Additional notes on transport modelling and economic benefits
<b>Option 1</b>	Outputs of improved representation of Option 1 strategic transport model used.	HLU scenario output used.	<ul style="list-style-type: none"> <li>▪ PT travel, private vehicles, safety, and environmental benefits calculated using transport model inputs.</li> <li>▪ Active transport model and agglomeration derived with transport model inputs and benchmarked against previous model runs.</li> <li>▪ ‘What-if’ high land use scenario based on LGWM Urban Development assumptions.</li> </ul>
<b>Option 2</b>	No new strategic model runs performed. Based on previous model outputs supporting Consultation material, with adjustment to the transport modelling outputs to reflect recent model improvements.	No strategic model runs performed. Inferred based on HLU scenario analysis performed on Option 1 with adjustment to reflect reduced potential on stimulating urban intensification compared to Option 1.	<ul style="list-style-type: none"> <li>▪ Based on previous model outputs supporting Consultation material, with adjustment to the transport modelling outputs to reflect recent model improvements.</li> <li>▪ Inferred transport model adjustment from Option 1 as similar transport network impacts, with key difference in mode vehicle.</li> <li>▪ Benefits benchmarked and factored using previous relativity of benefits between Option 1 and 2.</li> <li>▪ Although this option also provides improvements to all modes of transport, it is less focussed than Option 1 on stimulating intensified urban development. As a result, outputs for the HLU scenario have been revised downwards by 20% to reflect this. This adjustment is consistent with preliminary views about differences in urban intensification between Options 1 and 2.</li> </ul>
<b>Option 4</b>	Outputs of improved representation of Option 4 strategic transport model used.	Option 4 (with HLU scenario assumption from Option 1) used.	<ul style="list-style-type: none"> <li>▪ PT travel, private vehicles, safety, and environmental</li> </ul>

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Options	Core Land Use Scenario	High Land Use Scenario	Additional notes on transport modelling and economic benefits
			<p>benefits calculated using transport model inputs.</p> <ul style="list-style-type: none"> <li>▪ Active transport model and agglomeration derived with transport model inputs and benchmarked against previous model runs.</li> <li>▪ Results for the high land use scenario is most likely to over-estimate programme benefits as this assumes that Option 4 contains sufficient capacity to generate AND accommodate the increased network demands.</li> </ul>

#### 4.4 Summary results

Summary CBA results are presented in Table 4-3 and Table 4-4 below, for the base core and high land use scenarios respectively. They demonstrate that the high land use scenarios produce significantly higher transport network benefits and slightly lower agglomeration benefits than the core land use scenarios.

Option 1's high land use scenario generates the highest possible Net Present Value (NPV) of \$697 million and a benefit cost ratio (BCR) of 1.20. Option 2 is also likely to generate a NPV of \$223 million and a BCR of above 1. Whilst Option 4 high land use scenario indicates a high BCR, this is likely to be over-stated as this simply assumes land use assumption from Option 1.

Preliminary transport modelling outputs from core land use model run of Option 4 indicates that it is unlikely to be able to accommodate this scale of demand on the network. Furthermore Option 4 high land use scenario generates lower agglomeration benefits than the Option 4 core scenario due to the fact that the high land use scenario will relatively higher effective job density in the CBD.

We note that discussion is ongoing, within the LGWM analytical team, about the volume of additional cycling trips that can be expected as a result of Programme investment. WCC analysis performed for other, similar projects suggests that these benefits could be significantly higher for the LGWM parts of the strategic bike network. The 'Health Benefits for additional cycling trips' row in the tables below should, therefore, be interpreted as subject to change.

**Table 4-3: Core land use preliminary CBA Results (Discounted, \$2021 millions)**

	Option 1	Option 2	Option 4
<b>Viability metrics</b>			
NPV (excluding agglomeration)	-\$1,896	-\$1,634	-\$1,317
BCR (excluding agglomeration)	0.46	0.51	0.53
NPV (including agglomeration)	-\$1,137	-\$924	-\$780
<b>BCR (including agglomeration)</b>	<b>0.68</b>	<b>0.72</b>	<b>0.72</b>
<b>Costs</b>			
<b>Total costs</b>	<b>\$3,500</b>	<b>\$3,312</b>	<b>\$2,781</b>
<b>Benefits</b>			
Public transport – travel time benefits	\$640	\$679	\$603
Public transport – incremental fare revenue benefits	\$101	\$107	\$87
Private vehicle – travel time benefits	\$143	\$147	\$135
Private vehicle – travel time reliability benefits	\$11	\$12	\$9
Private vehicle – reduction in vehicle operating costs	\$91	\$91	\$82
Safety benefits	\$109	\$112	\$85
Environmental Benefits - Harmful pollutant and CO2 reduction	\$31	\$31	\$27
Health Benefits for additional walking trips	\$405	\$423	\$369
Health Benefits for additional cycling trips	\$73	\$76	\$66
Agglomeration	\$759	\$710	\$537
<b>Total benefits</b>	<b>\$2,363</b>	<b>\$2,388</b>	<b>\$2,001</b>

**Table 4-1: High land use preliminary CBA results (Discounted, \$2021 millions)**

	Option 1	Option 2	Option 4
<b>Viability metrics</b>			
NPV (excluding agglomeration)	-\$334	-\$686	-\$168
BCR (excluding agglomeration)	0.90	0.79	0.94
NPV (including agglomeration)	\$697	\$223	\$278
<b>BCR (including agglomeration)</b>	<b>1.20</b>	<b>1.07</b>	<b>1.10</b>
<b>Costs</b>			
<b>Total costs</b>	<b>\$3,500</b>	<b>\$3,312</b>	<b>\$2,781</b>
<b>Benefits</b>			
Public transport – travel time benefits	\$740	\$714	\$624
Public transport – incremental fare revenue benefits	\$319	\$273	\$226
Private vehicle – travel time benefits	\$353	\$245	\$293
Private vehicle – travel time reliability benefits	\$21	\$15	\$19
Private vehicle – reduction in vehicle operating costs	\$302	\$203	\$263
Safety benefits	\$391	\$261	\$327
Environmental Benefits - Harmful pollutant and CO2 reduction	\$97	\$66	\$84
Health Benefits for additional walking trips	\$799	\$720	\$659
Health Benefits for additional cycling trips	\$144	\$130	\$118
Agglomeration	\$1,031	\$908	\$447
<b>Total benefits</b>	<b>\$4,197</b>	<b>\$3,535</b>	<b>\$3,059</b>

Examining the detail of the CBA reveals a substantial increase in health benefits for users of active modes of transport. Walking and cycling benefits are distributed across the city but concentrate in and around the CBD where pedestrians and cyclists gain significantly improved infrastructure, leading to greater demand. The high land use scenario also introduces a noticeable additional increase in health benefits for pedestrians and cyclists from the core land use scenario.

## 5 CBA Review Conclusions

Our conversations with the wider LGWM team and review of CBA documentation indicates that **an appropriate and proportionate range of costs and benefits** have been considered as part of IBC development. The Programme team have clearly recognised the challenge of modelling and forecasting regional transformation and scoped their analytical workstreams accordingly.

We understand that, over the last year, a LGWM Technical Advisory Group has been convened in order to provide space for discussion, challenge, and critique. Several analytical approaches have been reconsidered and refined in response to feedback. In our view this is a valuable and important innovation, particularly where responsibility for Programme modelling is spread across several organisations.

LGWM team members have noted a small number of analytical gaps where modelling completed to date is uncertain, incomplete, or inconsistent. These consist of:

- A benefit profile based on exogenous intensification assumptions, as opposed to a quantitative model output. This 'higher land use' scenario is intended to explore what would happen if growth policy settings and levers were adjusted in parallel to LGWM investment, in alignment with local, regional, and national policy.
- The economic evaluation to-date focuses primarily on transport benefits and has not fully considered the broader benefits that LGWM could deliver, such as urban form and social benefits.
- Forecasts of public transport uptake remain uncertain across Programme options and highly sensitive to assumptions. LGWM team members have responded by reporting on the more conservative benefit estimates while explicitly noting the potential for change.
- Assessment of one of the four Programme short-list options was discontinued part-way through the CBA process. This could be described as a pragmatic response to emerging evidence more than an analytical deficiency, as the joint MRT/SHI consultant team proposed that sufficient modelling had already been completed to understand relative performance. A decision was made to leave this option 'as is'.

We agree that three out of the four of these gaps are suboptimal and represent areas that require additional analysis prior to final Programme investment decisions being taken. In our view, however, none of the issues are severe enough to undermine confidence in the IBC process as a whole. All three deficiencies relate to complex, difficult-to-measure benefits, where uncertainties and a reliance on exogenous assumptions are common across New Zealand transport Programmes. More importantly, the LGWM Programme team was successful in proactively identifying these limitations and including them in IBC advice.

Our answers to our six strategic review questions are set out in the table below:

**Table 5-1: Review conclusions by Strategic Question**

Question	Answer
1. <b>Standard procedures:</b> Have good-practice costs and benefits been considered and assessed by the Programme team?	Yes. The scoping, discussion and review of CBA methodology is clearly evidenced by Programme documentation. Good practice has been further supported by iterative consultation with Waka Kotahi experts
2. <b>Strategic alignment:</b> Are the unique strategic objectives of the LGWM Programme adequately reflected in the scope of CBA modelling?	Yes. Objectives such as regional transformation have been reflected in planning documents and discussions. The unique objectives of the Programme will be further explored as part of DBC analysis
3. <b>Recognising uncertainty:</b> Have significant sources of variation and risk been identified and communicated to decision-makers?	Yes. A number of uncertainties and risks are discussed in detail within key documents such as the <i>LGWM Programme Preferred Option Report</i> . This Technical Report identifies additional sensitivities that could be explored as part of DBC development
4. <b>Modelling approach:</b> Are CBA design choices and assumptions aligned with published Government guidance?	Yes, where appropriate. Alignment is evidenced by methodological referencing as well as direct Waka Kotahi consultation. Where alternative approaches have been applied, they are clearly documented and explained
5. <b>Fit-for-purpose:</b> Is the analysis sufficient to provide decision-makers with the evidence necessary to make an informed decision?	Yes. See section 3 of this paper for an in-depth discussion of IBC expectations
6. <b>Next steps:</b> Has IBC analysis laid the groundwork for a successful and appropriate DBC?	Yes. Risks and opportunities for DBC analysis are considered and communicated throughout Programme documentation. This Technical Report provides an additional source of intelligence for DBC planning

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## 6 Next Steps: Considerations and Sensitivities

The remainder of this Technical Report explores and proposes options to strengthen Programme analysis at the DBC stage. This Section explores material analytical considerations, identifying where Programme CBA could be refined and sharpened as part of DBC assessment. It begins by highlighting key dependencies and potential biases within economic case assessment tools such as CBA before discussing the accuracies that can arise if model specification is inconsistent or simplistic.

As discussed in Section 2 above, we note that simplifying assumptions are entirely appropriate for IBC documents. Applying the more sophisticated tools and approaches described below would have been disproportionate for IBC-stage analysis.

Although the majority of these simplifying assumptions are conservative, in the sense that they are most likely to understate Programme benefits, it is not certain that overall BCRs will increase at DBC stage. This is because 'unknown unknowns' exist and cannot be predicted with any degree of confidence, so any speculation about DBC conclusions would be notional and speculative.

Several dimensions of CBA are critical for decisionmakers to understand in the context of large, complex Programmes. This is because technical modelling choices are likely to have large and unexpected implications for CBA results when:

- Programme options represent long-term scenarios, rather than simple, one-off government decisions.
- A degree of judgement is required to determine what would happen in the absence of government intervention.
- A Programme is expected to provide a wide range of benefits.
- Benefits are difficult to measure and / or attribute to a specific government intervention.
- Benefit realisation depends on behavioural choices by citizens and businesses over time.

In these circumstances, summary outputs such as BCRs and net benefit values have the potential to mislead decisionmakers. Economic assessment results are unlikely to indicate the sensitivity of viability or efficiency conclusions. Arguably all of these criteria apply to the LGWM Programme.

Two common and significant examples are the definition of the Do Minimum and the scope of benefits estimated within the CBA. The potential implications of these considerations, as well as methods to ensure key sensitivities are adequately considered in DBC analysis, are set out below.

### 6.1 The importance of the Do Minimum

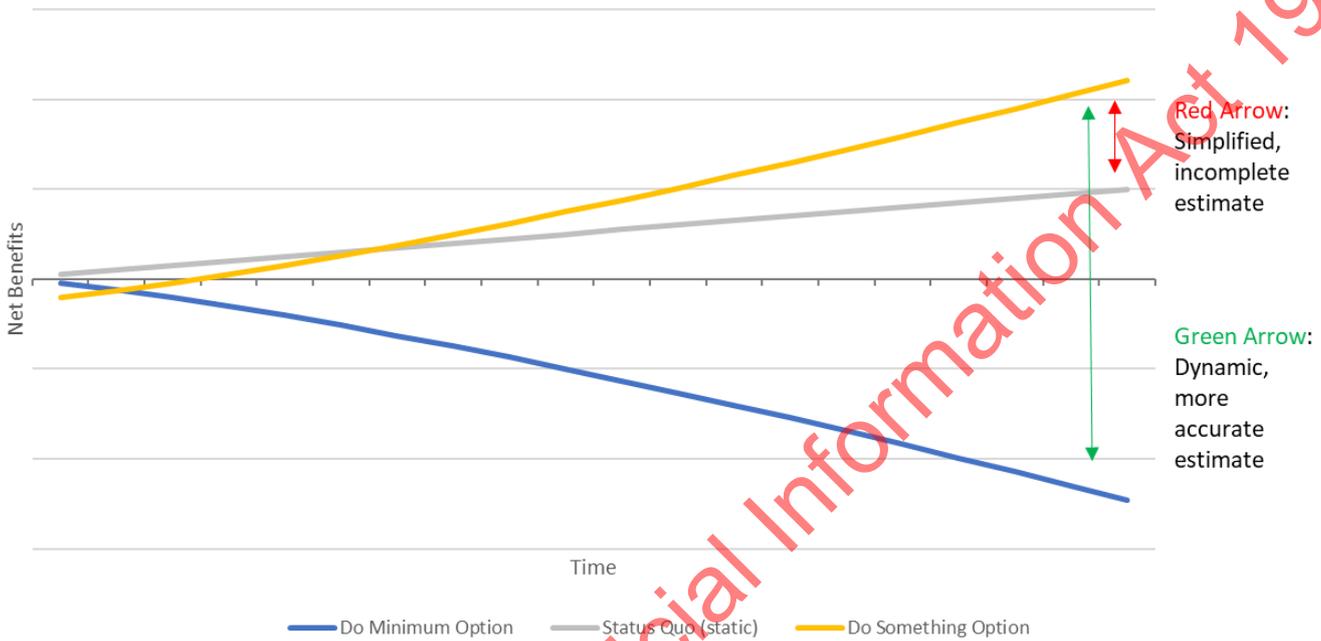
In a CBA, options are compared to a baseline scenario where Government intervention does not occur. This is the way we expect the Programme area, and the Wellington Region as a whole, to behave in the absence of the Programme investment. A "Do Minimum" is not a "do nothing." Government would still expect to maintain, and invest to cope with growth, in line with statutory obligations and land transport requirements set out in legislation. Such requirements are not cost-free, hence a Do Minimum option will often involve both costs and benefits.

The Do Minimum can also be understood as the "coping" option where government tries to not make things demonstrably worse than the status quo. But it is important to recognise that most Do Minima incur the costs associated with baseline forecasts (e.g. growing GHG emissions in the transport sector) in addition to financial cost (e.g. road maintenance).

Decisionmakers should, therefore, consider the long-term costs and network effects of the status quo when comparing options. CBA to support small-scale, low-risk projects often make a simplifying

assumption that the Do Minimum involves zero costs or benefits. Such an assumption is inappropriate and inaccurate for a region-shaping Programme such as LGWM, where Do Minimum impacts on funders, businesses and households are substantial. This is discussed in more detail in Section 7.

**Figure 6-1: Indicative Option impacts net of the Do Minimum**



One of the single largest influences on Do Minimum costs and benefits (as well as the performance Programme options) is population growth forecasts. Population growth is often a core determinant in the economic viability of major urban transformation projects in the transport sector, regularly dictating whether a Programme BCR is greater than 1. This is because almost all monetizable factors are correlated with the number of users, for example time (saved or lost), emissions and safety. Effects on mode shift and public transportation can be non-linear, for example where the viability of a mass transit system depends on a critical mass of local commuters.

Typically, major urban transformation projects incur the majority of costs in the first 10 years, but often only receive meaningful benefit streams in the last 10 years of the project (as the number of additional users reach a critical mass). An issue is created when future benefits are heavily discounted and / or a static land use approach is applied to analysis (where there is no population response to the investment). Regional transformations Programmes that intend to shape long-term travel patterns are heavily penalised by such methodologies. Sensitivity analysis, with respect to discount rates and analysis periods, are discussed in Section 9.

**6.2 Population growth**

As discussed above, BCRs compare the difference between costs and benefits under the Do Minimum with the costs and benefits under 'do something' options. Results are driven partly by the quality of the Options, which is where most of the focus of decision-makers lies, but are equally, if not more reliant on the reduction in quality, level of service and level of well-being from the Do Minimum – which is driven by population growth. Inaccuracies arise, however, if population projections are simplified or otherwise incomplete, for example if dynamic response from households and businesses are not considered.

Publicly available forecasts in New Zealand have, in the last 20 years, underestimated population growth.<sup>4</sup> This arguably creates a systemic bias against long-term transformational Programmes, manifest in ‘under-costing’ Do Minimum Impacts over time.

In 2020 New Zealand’s population reached 5 million people. That is almost 10 years faster than Statistics New Zealand forecast in 2006, and almost 3 years faster than Stats NZ forecast in 2013. The impact is tens of thousands more households travelling, using schools, hospitals and utilities than was anticipated, all of which should have been reflected in economic assessment exercises.

While three years may not sound like a long time, the nature of exponential growth means that such an inaccuracy will have significantly altered the evidence presented to decision-makers at the time. The business cases on these projects cover 40-60 years, so divergences will accumulate over time. Using the 2006 estimates meant decisionmakers were potentially underestimating the value to users of these projects by up to 25%.

To ground this in reality it is useful to consider a snapshot of New Zealand infrastructure projects where investment decisions have been based on underestimates of population, such that transformational options will have been undervalued. The table below highlights that underestimation has been a regular occurrence, even where considerable economic modelling and sensitivity analysis was performed.

**Table 6-1: Population Assumptions across NZ Infrastructure Projects**

Projects using 2006 population projections (5 million people by 2030)	Projects using 2013 population projections (5 million people by 2023)
Auckland double tracking, electrification and EMU purchase	Wellington trolley bus decision/bus contracting
Wellington rail network improvements (extension of electrification, new EMUs etc)	Transmission Gully
Tauranga Eastern Motorway	Puhi to Warkworth
Victoria Park Tunnel	City Rail Link
Waterview Tunnel	Peka Peka to Otaki
Kapiti Expressway	ATAP projects
Christchurch Transport Interchange	Huntly By-Pass
Christchurch Accessible City Programme	Auckland Light Rail Stage 1
Lower Hutt Dowse to Petone	Wellington integrated fares
Most of Waikato Expressway	SH58 Improvements

There remains a risk that the published Statistics NZ forecasts continue to underestimate population growth. The current projection, which underpins LGWM Programme CBA, is that we will reach 6 million people by 2050. But, in addition to questions of population redistribution, these figures are highly dependent on net migration in a post-COVID world. If New Zealand returned to its pre-COVID net

<sup>4</sup> Referred to in this Technical Report as “static” growth because dynamic redistribution is not considered

migration average of around 50,000 per year, we would reach 6 million people by 2040 on net migration alone (i.e. excluding domestic growth).

A net increase of 75,000 people per year (pre-COVID net migration plus natural increase) would see a population of 6 million by 2033 – 17 years sooner than the Statistics NZ forecasts. For context, New Zealand took 17 years to grow from 4 million people (2003) to 5 million (2020). This suggests an uncertainty band of up to 100% of historic growth levels.

Underestimating population growth, and therefore potential demand, can result in under-calculating the benefits of the Programme options. Section 7 of this Technical Report explores the effect of 'rebasings' population forecasts on the LGWM Programme and demonstrates the significance of this on the BCR. Modelling completed to date does not include a fundamentally higher base population in the Do Minimum, but this would have a similar, and potentially greater impact. Any improvement to the performance of 'do something' options are additional to decreases in the performance of the Do Minimum.

### 6.3 Dynamic Do Minima

Another barrier to the accurate estimation of Do Minimum impacts, over and above forecasting challenges, is the nature of population flows in a region over time. Even under a Do Nothing scenario, firms and households will make decisions about where they choose to operate, live, and work. Local residents will respond to a lack of investment in the same way they can be expected to respond to successful regional transformation, for example making relocation decisions in response to congestion, accessibility, and public transport capacity trends.

In the original LGWM Programme Business Case published in 2018, economic viability conclusions were significantly influenced by base case assumptions. The Programme area (Wellington CBD, Te Aro, the South and the East) was assumed to never reach capacity under the Do Minimum. This runs contrary to historic trends, where many households in the Wellington region have responded to location choices by 'drifting' northwards over the last fifteen years (in some cases suburb by suburb).

Such situations introduce an error of omission, rather than under-forecasting. Within a static population model, growth at a sub-regional level will remain constant, outside of exogenous factors such as demographics and migration. Growth will halt, in a binary manner, when a limit on capacity is reached. By extension, 'at capacity' population levels can be treated as an indicator of inadequate infrastructure, and evidence of missed opportunities.

While logical within a static economic model, population capacity is not an accurate or reliable indicator of deficiencies in a transport network in the real world. As discussed above, individual households will respond to trends in infrastructure quality as they emerge, based on their own experiences and preferences, as opposed to acting as a single uniform group. Behavioural responses will, in reality, accumulate gradually until an equilibrium is reached. Transport network deficiencies may actually prevent the 'capacity limit' figure ever being reached, rather than the later providing evidence of the former.

Programme BCRs will therefore be artificially low where static capacity limits are treated as a necessary and sufficient condition for inadequate transport services. This conflation of demand forecasts and behavioural responses means that relevant, material costs will be excluded from Do Minimum estimates. As demonstrated in Figure 6-1 above, this decreases the net benefits and (by extension) BCR of 'do something' Programme options.

Omitting substantial costs from the Do Minimum is one of the principal reasons why the LGWM Programme has received modest BCRs to date: Modelling does not recognise pressing problems in the region because artificial criteria for inadequacy are not met. To put it another way, **households and**

**businesses exiting geographic areas in response to declining transport service quality is interpreted as evidence of adequate transport capacity.** It is also entirely possible that these entities shifting further north are different to those that would be attracted into the region under a Programme option. In other words, there may be a significant omitted benefit in retaining these households whose first choice is to remain in the Programme area.

#### 6.4 What is quantified and what is not – The Importance of Dynamic WEBs

CBA models vary significantly in breadth and depth, so it is important to understand what makes up a BCR. We note that there is no ‘right answer’, and judgement is required to determine whether these items should be presented more often. In many cases it is not appropriate for a project to analyse in any detail basic Wider Economic Benefits (WEBs). For example, a passing lane in regional New Zealand will not offer any tangible WEBs. The table below sets good practice for major urban programmes such as LGWM.

**Table 6-2: The treatment of Wider Economic Benefits in programme economic assessment**

Always Presented	Often Presented	Rarely Presented	Not part of approach
Travel time saved and lost	Agglomeration – people being more productive due to location	Dynamic land use response to investment	Dynamic Do Minimum (as discussed in the Section above)
Carbon dioxide emissions (noting the Waka Kotahi shadow price now includes a range of scenarios)	Impacts on mode shift and associated carbon dioxide emissions	Total greenhouse gas emissions, beyond carbon (CO <sub>2</sub> -e)	Emissions Trading Scheme impacts in terms of abatement credits (e.g. savings through decarbonisation)
Safety impact of reduced (or increased) deaths and injuries	Particulates from diesel – namely PM10	Other dangerous emissions from diesel fuel – namely Sulphur and Nitrous Oxides	Path dependency implications, where government investment shapes long-term network planning and mode choice
Construction cost of the Programme	Employment impacts	Resilience values other than improvements in average trip times reflected in time calculations	Economic impact of the region from delay in Programme execution (the cost of delay)
Maintenance and renewal cost of the Programme	Vehicle operating costs (or savings)	Construction costs of projects forgone or delayed outside of the Programme – related to the dynamic land use response	Wider housing and development benefits (e.g. better affordability through increased housing supply)
	Imperfect competition impacts	Related to dynamic responses – signal value of investment	

Always Presented	Often Presented	Rarely Presented	Not part of approach
		Cost to funders apportioned, and in particular where there is alternative funding	

As previously discussed, much of the BCR analysis relies on population – how many people and businesses are in the Programme area, and how many will there be. This dictates the number of people who will be impacted through time saved, carbon emitted, accidents, operating costs etc.

Many transport programmes are evaluated based on an assumption of fixed land use – this is where the population and business forecast for the Programme and its investment remains largely unchanged from the Do Minimum. The Programme is evaluated on its ability to resolve issues and create benefits for people who are forecast to be in the study area, regardless of the investment made. In many cases, fixed land use is appropriate, especially where it is difficult to attribute changes in land use to the transport investment made.

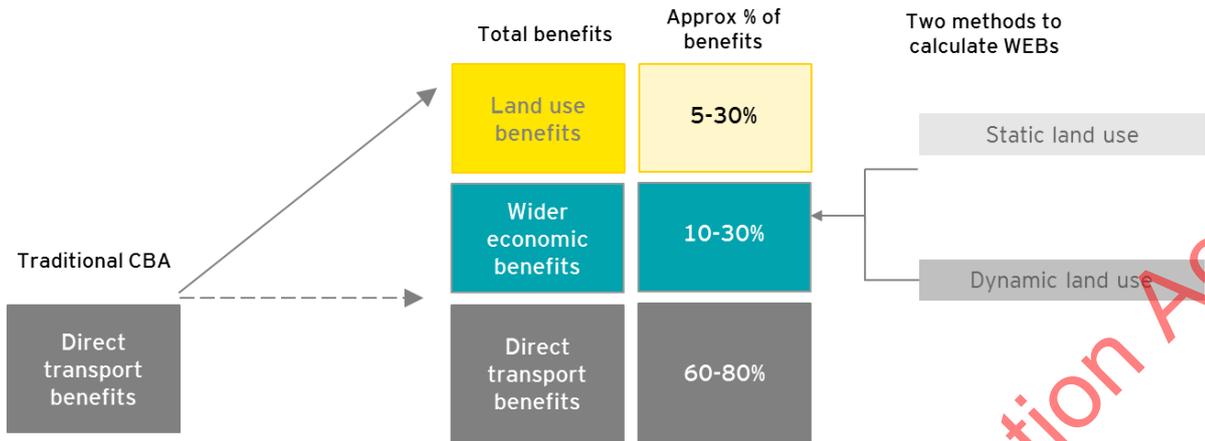
For a complex urban Programme like LGWM, a fixed land use assumption is implicitly arguing that no household relocates, no business relocates and the only people who benefit from the Programme are those who are forecast to remain. This is clearly inaccurate for a Programme explicitly focussed on regional growth and transformation.

Fixed land use analysis also impacts the design process materially. Because there is no behaviour change in terms of location (business and household) choice in the analysis, the only monetisable benefit from design that increases amenity, placemaking and encourages better land use (e.g. housing intensification) is that gained through mode shift (i.e. making public transport or cycling more accessible or attractive).

With no land use change (and no incentive to design for it), this also makes third party contributions to the cost of the project largely impractical to evaluate. In order to capture value, the Programme must first create the value and analyse it.

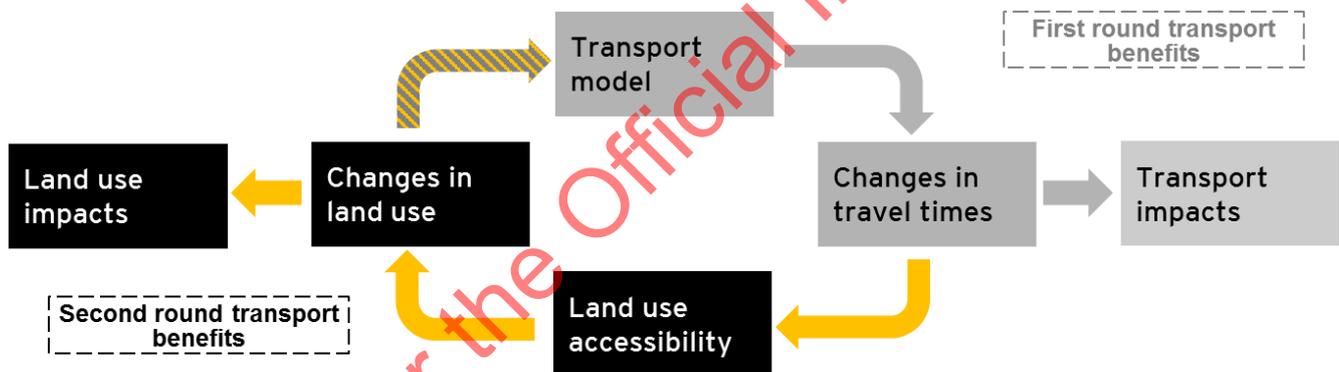
Waka Kotahi now have allowable processes to evaluate what is called dynamic wider economic benefits the main component of which is dynamic land use responses to the investment. The potential value of this analysis is shown in Figure 6-2 below.

**Figure 6-2: The potential value of Wider Economic Benefits**



Waka Kotahi have a simplified procedure and complex procedure allowed for the calculation of dynamic land use. Both effectively follow the prescription below:

**Figure 6-3: Calculating dynamic land use benefits**



In the figure above, an important feature is the feedback loop from land use change back into the transport model. Land use change means more people and businesses in the Programme area compared to the static approach which means:

- More public transport patronage
- Greater farebox recoveries (linked to the above)
- More saved carbon from mode shift
- Reductions in average time saved (as roads are more congested compared to static analysis) but increases in total time saved (as there are more users benefitting from the investment).

To date, the LGWM Programme have followed a variation of the simple procedure. This is appropriate for two reasons:

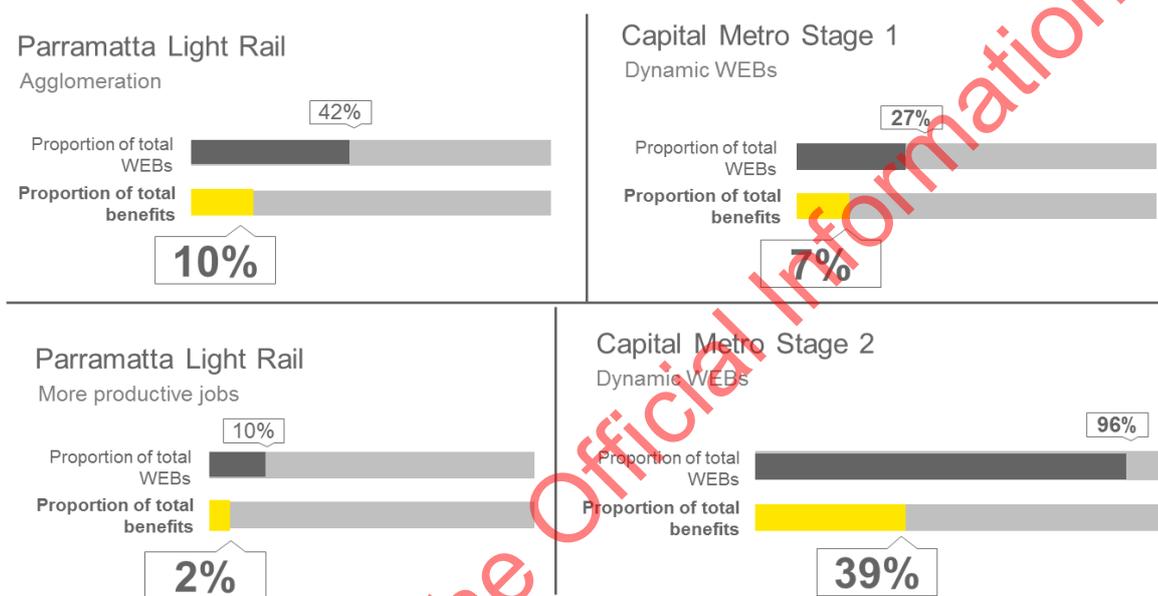
- i The analysis is only at the Indicative Business Case Stage and therefore is not yet at the level of design where investment of time in the complex process would deliver robust results.
- ii There have been questions of attribution between projects within the programme with their individual IBCs, where project teams took a justifiably conservative approach to land use

change in their projects so as to avoid double counting benefits with another project. This was a particular concern with the MRT and State Highway projects, but also applied to Golden Mile and MRT.

The Programme Report has made considerable improvements to the dynamic calculation, but these retain a “top-down”/principles-based approach, thus keeping it within the scope of the simple procedure. To reiterate, this is appropriate for the Indicative Business Case stage of the Programme.

The complex approach is one adopted and adapted from the approach used and accepted in Australia. This has delivered results that have a material impact on the benefits of major urban mass rapid transit projects, as shown below.

**Figure 6-4: Dynamic land use benefits in Australia**



The important conclusion is that at this stage of the analysis, we consider that there are material uncounted benefits that can be monetised appropriately under the Waka Kotahi’s complex method at the Programme Level once the Detailed Business Cases commence.

## 7 Opportunities for Low-Effort, High-Impact Analysis

This Section considers four areas that are not presently monetised within LGWM analysis, and could have additional analysis articulated in the DBC. These four areas are at the more straightforward end of the analysis and three of the four are allowable under Waka Kotahi's Monetised Benefit and Costs Manual (MBCM). The BCR of Option 1, for example, could increase from 1.2 to 1.7 if a 10-year delay were assumed as part of the Do Minimum (potentially reducing the net cost of the option by \$1,000 million in NPV terms).

### 7.1 The value of signalling

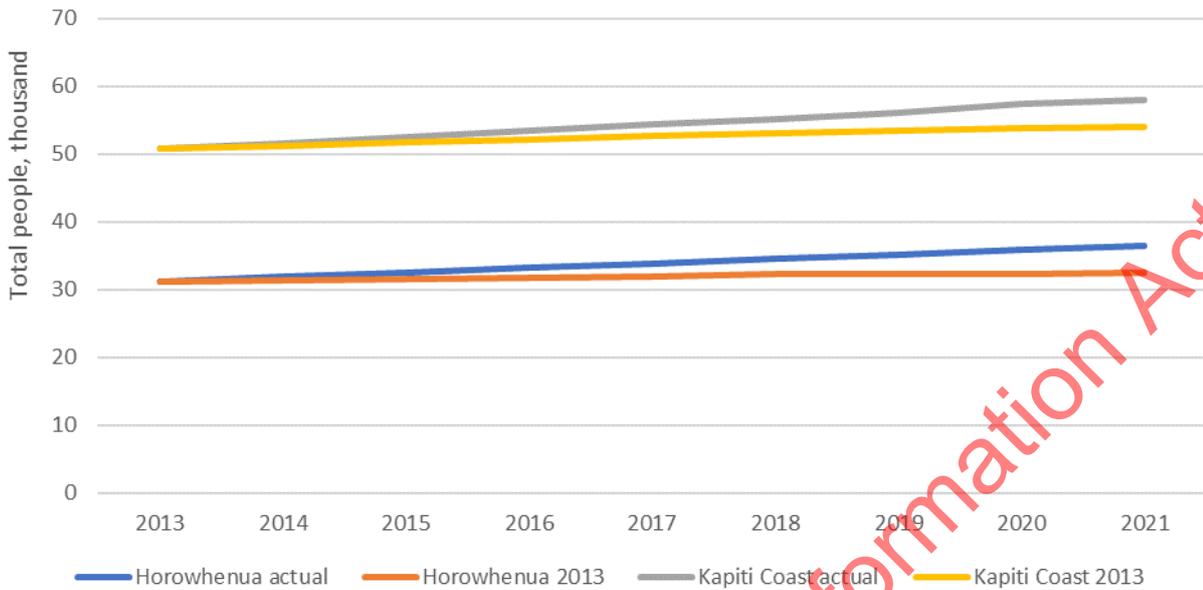
When assessing CBA's, the usual approach is to measure the costs of the Programme from the day of construction start, but not measure the benefit stream until the day the project goes live. This is appropriate under a static land use analysis as there is no response to the announcement of the investment. But there is strong evidence that under a dynamic land use, the response to investment occurs well before the delivery date of the programme. New Zealand has had three very recent tangible examples:

Work undertaken for Waka Kotahi in 2018 around the Manawatu Gorge Replacement included a market sounding of private investment intentions in the region. The sounding estimated around \$45 million of investment waiting for certainty around the preferred option (this did not include KiwiRail's Bunnythorpe plans). While the majority of this investment would occur anyway, timing was critical, and would occur between project funding decision and project delivery.

Between the Notice of Requirement decision and the Crown's funding decision for City Rail Link approximately \$200 million of investment went into Albert Street in the Auckland CBD. This included commitment to a major development on the site over the proposed Aotea Station between Sky City and the Crowne Plaza. There has been subsequent material investment along the CRL Route after the Crown's funding decision, including the Commercial Bay development. Again, while this investment would have happened anyway, it is uncounted in both static land use, and because it occurs prior to project delivery, yet as materially re-based the population in the project area.

In the Wellington Region, the population in the Horowhenua and Kapiti Coast changed materially compared to the Statistics New Zealand population forecasts. This divergence began in a material way in 2014, coinciding with the announcement of Transmission Gully and the ongoing development of the Kapiti Expressway.

**Figure 7-1: Population projections for the Transmission Gully Project**



This growth is uncounted in the business cases for Transmission Gully, the Kapiti Expressway and also Peka Peka to Otaki. Even if a static land use was used once the projects were delivered, each project would start on a materially higher user base on Year 0 compared to their respective business cases.

It is allowable under the MBCM to count population responses to investment decisions prior to project delivery (Project Year 0) where there is sufficient evidence to do so.

A simple approach to this for Let's Get Wellington Moving would be to apply the current simplified dynamic growth approach used (i.e. the growth percentage over and above static land use) to the construction years to re-base the population in the Programme catchment. This is not an insubstantial impact on the CBA because the growth percentage even under a medium growth profile is material, and a construction period of over five years gives a significant rebasing of population by the time the Programme is implemented.

## 7.2 Population modelling and air pollutants

We understand that forecasts are presently being developed that will estimate and apply a new average growth rate after Programme construction begins. In the interim, however, the LGWM High Land Use scenario (which is a useful proxy as both approaches result in more population in the Programme area, faster) is indicating a doubling of conventional transport benefits, with a similar impact on Wider Economic Benefits.

To date the focus of the Programme analysis has been on decarbonisation and the monetised carbon impacts of the options. There are potentially additional significant benefits of further analysis on diesel-related emissions that have not been fully assessed. Carbon is presently valued in the MBCM at less than \$70 per tonne. Sulphur dioxide – a major pollutant from diesels does not have a value assigned in the MBCM, but recent work for the Ministry of Transport for the Crown's Rail Strategy agreed to use the Ministry for the Environment figure of around \$18,000 per tonne.

The LGWM Do Minimum already assumes an aggressive move away from diesel use to electrics in public transport. As such, the first order benefits of the options from counting non-carbon emissions will be muted. Where significant benefits can be gained is through mode shift from private vehicles to public transport or walking/cycling.

Using a simple approach of mode shift from private motor vehicle users being in proportion to vehicle type would see significant increase in sulphur dioxide benefits. Nitrous oxides and PM10 have lower values, but can be modelled in the same way, with the emphasis being on mode shift from private vehicles to public transport fleet that already has high degrees of electrification.

### 7.3 Updated GHG Analysis

A sensitivity of carbon price would also be a useful addition to the analysis. Waka Kotahi have had previous research undertaken that suggests the carbon price in the MBCM should be in the vicinity of \$90 per tonne. This is reflected in the latest version of the MBCM, where a range of shadow prices are included. Moreover both 'high' and 'low' carbon prices grow in real terms over time.

Additional analysis of GHG emissions impacts should be relatively straightforward due to publicly available modelling tools such as the Vehicle Emissions Prediction Model (VEPM). As such, there would also be value in the Programme considering two other GHG-related scenarios for the purposes of sensitivity testing. Including the carbon price range identified above, these consist of:

- High and low shadow prices for carbon (\$61 - \$122 in 2021)
- Limiting anticipated efficiency gains in the performance of petrol and diesel engines (e.g. applying 2022 emissions factors)
- Applying CO<sub>2</sub>-e emissions, or carbon dioxide equivalent values, which represent a more accurate and internationally recognised approach to measuring GHGs.

While out of scope for an economic analysis focussed review, we note that greenhouse gas (GHG) emissions are likely to become increasingly important from a strategic perspective. The Climate Change Commission in New Zealand has published ambitious mitigation targets for the transport sector, the achievement of which relies on significant change to investment planning in large regions such as Wellington. It is likely that, by the time a final Programme DBC is being considered, decreases in transport emissions will be seen as a baseline requirement for NLTP funding, as opposed to a monetisable part of CBA subject to trade-offs.

### 7.4 Calculating returns to government

As noted above, LGWM has already undertaken a simplified dynamic land use calculation which has resulted in more development and more intensity in the study area. It is possible, and there is work ongoing within the LGWM programme around this, to determine the commercial value of that land use change to developers and builders.

Currently, the LGWM analysis presents the BCR as national (public and private) benefits and costs. This is known as BCR(n). BCR(g) is an allowable process by which you can subtract 3<sup>rd</sup> party contributions to the project costs from the cost component of the benefit cost ratio. It was originally developed for tolling projects and allowed Waka Kotahi to subtract toll revenue from the cost of the project when calculating the BCR.

A BCR(g) is calculated as the present value of national economic benefits minus the present value of private sector contributions, with the result then divided by the present value of net government costs. Benefits to government (the numerator) will usually be lower than total benefits, however a BCR(g) may still return a higher value if BCR(n) if costs net of 3<sup>rd</sup> party contributions (the denominator) are significantly lower than total costs.

The intent of BCR(g) is to give a more realistic view of the cost benefit analysis to **government** funders of the project. The principle being that 3<sup>rd</sup> party funders have already decided the project is a good idea, hence their willingness to pay, so their private benefit and private cost can be removed. The critical reason why benefits aren't also subtracted is that there is an underlying, uncounted consumer surplus to

the project from these funders in the normal BCR. Put simply, 3<sup>rd</sup> party funders would not pay more for the project if private benefits were wholly captured by the current BCR.

While this was created for tolling projects (where the road user pays), there is nothing stopping the process being used for major urban transformation projects where developers and other potential 3<sup>rd</sup> party beneficiaries have a willingness to contribute to the cost of the project. This could be through any number of mechanisms such as development contributions, targeted rates, value capture, sale of air rights, tax increment financing, or commercial partnerships between Waka Kotahi/WCC and 3<sup>rd</sup> party funders.

A very good example is Crossrail in London, where 1/3<sup>rd</sup> of the cost of the project was met by 3<sup>rd</sup> party funding, principally through the provision of air rights (which have been very commercially successful in this project).

One approach to measuring BCR(g) for LGWM at this very early stage would be to treat the value of a small reduction in house price escalation delivered through the ability to increase housing supply attributable to Let's Get Wellington Moving as a proxy for value to private developers. Across the entire Wellington Region, a small \$25,000 reduction in house price *inflation* (noting that March 20 to March 21 house price inflation in Wellington was over \$200,000 and average price has over doubled since 2015) delivers a \$300m annual benefit (reduction in prices) that is a real commercial impact for people trying to build and develop housing. If the Programme were to capture 20% of that value through any number of mechanisms (special purpose vehicle, targeted rate etc), it would deliver a total hypothetical private contribution of \$900 million over 40 years (discounted).

If 3<sup>rd</sup> party funding could reach \$150 million per annum, the BCR(g) could increase to over 1.5 for Option 1 and over 5.00 for Option 4. It is important to note that this approach is illustrative only and does not recommend any particular funding approach or apportionment of costs. What it does show though, is that with a focus on how land use will respond, and then creating detailed business cases that understand the commercial and economic value of the programmes to households, businesses and developers, there are a significant number of opportunities to create projects where co-funding offers meaningful financial benefit for all parties that can impact on the Programme BCR.

## 7.5 The cost of delay

BCRs as a measure of a project essentially answer two questions:

- Is this a good project?
- Is this a good project to do now?

This is discussed in more detail in Section 3. The LGWM transport modelling team have assessed that even with a current BCR of 0.46, if decisions were to be deferred, a decision made in the 2030's would see a project BCR of 1. If nothing else changed. In other words, taking a simple CBA approach, the Programme is still a good programme, it's just not being advanced at the correct time using the lens of Cost Benefit Analysis.

Financial Analysis is important in this respect. It is useful to revisit the points earlier, that the largest share of the costs of major transformational programmes occur up front in the first 10 years, so are least impacted by the discounting of future costs and benefits. The benefits, however, occur as population grows, which tends to reach critical mass in the last 10-15 years of the 40-year analysis period and are therefore impacted more by discounting in the BCR calculation.

It is useful to consider the impact of inflation for capital projects, particularly if these projects were to be debt-financed. It is probable the total capital cost of LGWM will be debt financed with financing costs being met by the project partners through rates and NLTF. The Treasury's current forecast for inflation

averages 2.5% for the next 5 years. Table 7-2 below estimates inflation adjusted nominal project costs for Options 1 and 4, based on these assumptions.

**Table 7-1: The cost of delay**

	5 year delay	10 year delay	15 year delay
Option 1	\$400m	\$1,000m	\$1,510m
Option 4	\$350m	\$750m	\$1,200m

Given projects are financed at the nominal cost at the year at which financing is advanced, it is always useful to consider the impact inflation has on the cost of the project if commencement is delayed. While this is picked up in the CBA in many respects, the CBA itself only considers that decisionmakers say yes or no to a project at a given point in time. The CBA never considers that a “yes” decision would be made at a later date. This is why the “cost of delay” analysis is important.

On top of financing and inflation of project costs, there is also the consideration of the financial and economic costs of the Do Minimum that would be incurred with any deferral of the commencement of the Programme. As discussed in the introductory Section, these costs are effectively “zeroed” in the CBA analysis because the purpose of the CBA is to compare the options to the Do Minimum. Deferral of a Programme will necessarily mean costs incurred with “coping” in the interim (e.g. maintenance and additional services). It also means the economic losses associated with lost time, carbon and dynamic population movement are also incurred in the intervening years. Again, this is picked up in the CBA for a Year 0 decision, but not for a deferred decision.

A similar, detailed exercise was undertaken for Waka Kotahi for the Manawatu Gorge replacement. The cost to the Central North Island economy of a 1-year delay in that particular project was 1/3<sup>rd</sup> of the total cost of the project.

## 8 Opportunities for High-Impact, Longer-Term Analysis

The focus of this report has been on potential adjustments to the Programme BCRs to the current Indicative Business Case stage. It is also worth the Board understanding the potential longer term material changes that can be made either as part of any Detailed Business Case for individual Projects in the Programme, or across the Programme as a whole. With the exception of the Resilience Section below, these key considerations have already been discussed extensively in this report.

In general, these longer-term considerations are focused on three key goals:

1. Better understanding and articulating what is actually happening in terms of population dynamics and being able to better forecast these in a robust and defensible way.
2. Creating the environment where value can be created and the DBC teams rewarded for the creation of that value through improved economic impact results.
3. Better articulating the financial/cost components and understanding the cost implications of the way decisions are made.

### 8.1 Dynamic Do Minimum calculation – along with a view on core population scenarios

The reasons for the dynamic Do Minimum and the risks with the population forecasts are extensively discussed in Section 6. We therefore recommend that core tasks for the Programme DBC include the following:

- Getting a better handle on what's actually happening in the Do Minimum, ensuring the baseline scenario is fully specified and understood.
- Understanding those "pushed" out of the analysis area and whether they are different to those being attracted in.
- Assess the "retained" population, improving the accuracy of CBA (which may make the Do Minimum "worse", i.e. more of a pressing problem, and therefore the options generate higher benefits earlier).

This work should commence well in advance of the Detailed Business Cases as it will materially underpin much of the analysis undertaken in the DBCs

### 8.2 Cost of Delay/Inaction – Modelled approach

The previous Section has shown a basic financial impact through inflated Programme costs through a deferral of the Programme into a future year. A more comprehensive modelled approach undertaken alongside the DBCs for each project can include:

- GDP/full Computable General Equilibrium modelling of economic impact to the region of delaying the projects. This can potentially include housing affordability impacts as well as agglomeration, productivity, employment, and higher value land use.
- Financial (capital cost and impact of rates) assessment of region-wide project implications (e.g. more capital investment to support different growth profiles as opposed to avoided or retimed investment from early investment).

### 8.3 Complex Dynamic WEBs approach

As discussed above, building on the simplified, top-down approach used in the IBC stage will deliver significant additional benefits for the Programme. It includes:

- Utilising the prescribed Dynamic WEBs approach (complex) in the Waka Kotahi Monetised Benefits and Costs Manual

- Commercial and economics workstreams (i.e. understanding population and housing investment responses, including commercial property)
- Identifying tangible opportunities for third party funding
- Delivering a fully integrated BCR(g) calculation which will significantly lift the BCR for government investors.

#### **8.4 The value of resilience**

One area not discussed in the report to date is the value of resilience. The current LGWM modelling does include modelling of reliability benefits, but Waka Kotahi's research shows there are significant additional resilience benefits that are often uncouncted, but allowable under the MBCM.

Resilience can include not only natural events, but also the ability of networks to recover from, and cope with, other disruptions such as major works or incidents on the network. We would expect both the MRT and State Highway projects would significantly add to the resilience of the Wellington networks, and applying Waka Kotahi's resilience framework will identify a range of benefits presently not accounted for.

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## 9 Sensitivity Analysis Completed

The final part of this review consists of sensitivity analysis performed by EY, spread across five outcome areas. These areas were identified as potentially having a material impact on the BCR, and have been analysed to review the potential effects and outcomes that any alternative assumptions would have. In some cases, we recommend that additional modelling is unlikely to add value. We note that this analysis is intended to inform prioritisation and planning decisions leading up to the Programme DBC and should not be read as definitive results.

### 9.1 Mode-specific preferences

Many transport models look at general behavioural preferences of travellers when they are considering public transport choices. There is a well-established hierarchy for public transit preferences:

1. Ferry
2. Heavy Rail
3. Light Rail
4. Bus Rapid Transit
5. Bus.

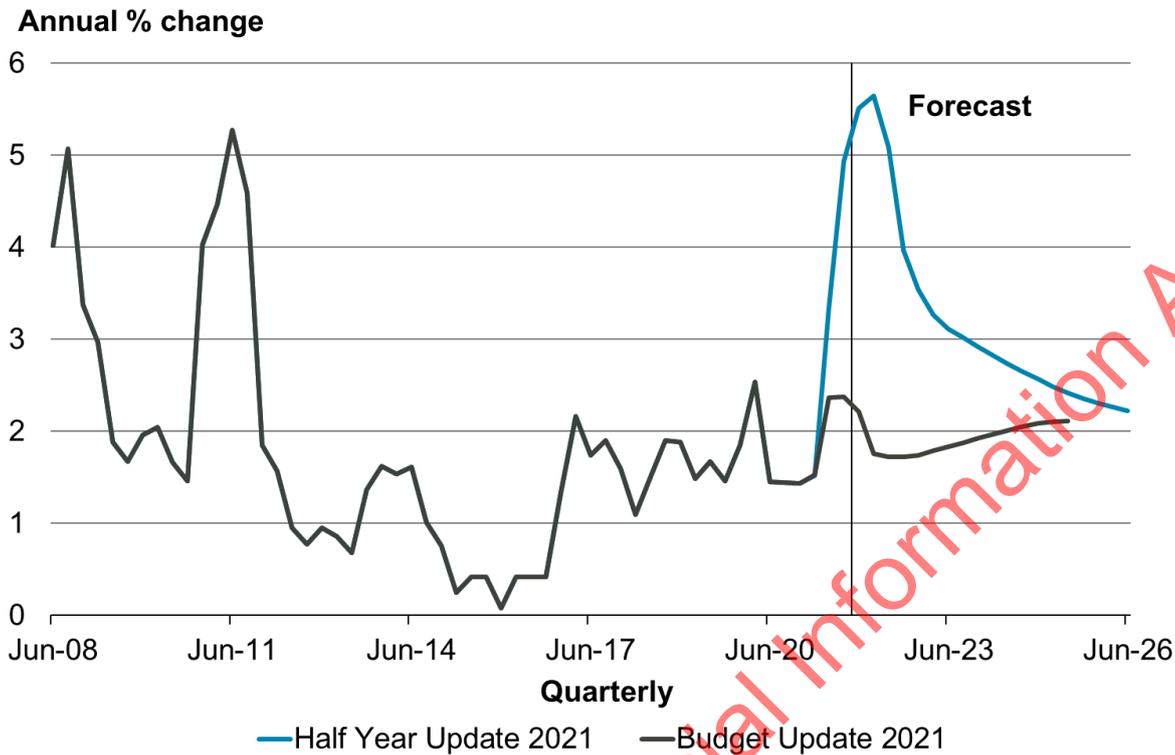
The modelling performed for LGWM has appropriately considered these choices alongside predicted traveller behaviour, with respect to the fact that the only feasible public transit options in the Programme area are light rail, bus rapid transit, and bus. From our testing, it is considered that further analysis at the DBC phase would not lead to materially different results.

### 9.2 Inflation forecasts

In the year to December 2021, the Consumer Price Index increased 5.9 percent. This is the largest annual increase since 1990. As such, it is worth reviewing whether New Zealand will move to a materially higher inflation environment than that which underpins the current LGWM forecasts.

The Treasury's Half Yearly Economic and Fiscal Update for December 2021 contains a consensus-based medium-term inflation forecast. This shows the present spikes will abate within the forecast period moving back to a reasonably stable 2.5% average:

**Figure 9-1: Budget 2021 Inflation Forecasts**



On this basis there is little justification to fundamentally revisit the inflation forecasts used by LGWM.

### 9.3 Population projections

These are discussed in detail in Section 6. At the IBC stage, and if a dynamic land use is developed further, the population projections should remain unchanged. However, for the reasons discussed above, the current projections should be viewed as conservative and have the impact of materially reducing benefits.

Further work and testing, along with development of the complex dynamic land use approach is a high priority. We recommend investigation and discussion of Programme-appropriate population forecasts be advanced as part of the DBC stage.

### 9.4 Modelling Safety Valve

Transport models aren't designed to "fail": They are designed to solve problems and identify the merits of solutions. The issue is, for major urban transport projects, the model "failing" on the Do Minimum is an important finding. What that means is that the network cannot cope with the growth that it is being asked to accommodate.

Most models have a safety valve where the model equilibrates when under pressure. This can occur in a number of ways. For Wellington, it appears that the system never comes under irresolvable pressure because households and businesses dynamically exit the LGWM programme area as part of the Do Minimum. In effect household and business behaviour is providing the safety valve, meaning there is a "real-time" failure as opposed to a modelled one.

### 9.5 Discount Rates and Analysis Periods

Consistent with the most recent Waka Kotahi guidance, a 4% discount rate has been applied alongside a 40-year appraisal period. A 60 period could also be considered in light of long-term Programme

ambitions. Reinforcing the recommendations within Section 8 above, Waka Kotahi emphasises the importance of accurate demand forecasting in such circumstances:

*An increase of the analysis period to 60 years is permitted to ensure that the whole-of-life costs and benefits of long-lived infrastructure activities are captured. An extension of the analysis period increases the importance of demand forecasting. Emphasis should be placed on developing a range of options and scenarios, and on reporting uncertainty in the business cases and economic evaluation, when the analysis period is extended.*

We recommend that, to inform discussion of long-term impacts and (if necessary) intergenerational equity, DBC analysis include the results of sensitivity testing. This could consist of a 2% and 6% discount rate, as well as a 60-year appraisal period.

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## 10 Conclusions and Next Steps

Our conversations with the wider LGWM team and review of CBA documentation indicates that **an appropriate and proportionate range of costs and benefits** have been modelled for the purposes of IBC development. The Programme team have clearly recognised the challenge of modelling and forecasting regional transformation and scoped their analytical workstreams accordingly.

Sensitivity analysis performed by EY and the LGWM team has identified a range of uncertainties, including (but limited to) land use intensification, pricing, mode-specific preferences, inflation, discount rates and future ways of working. In our view the potential for Programme assessment results to change has been clearly and effectively communicated within documents such as the *LGWM Programme Preferred Option Report*. It may be appropriate, at DBC stage, to collate and formalise this analysis into quantified uncertainty bands, for example through the use of Monte Carlo analysis.

A small number of analytical gaps have been identified by the joint MRT/SHI consultant team, for example a focus on traditional transport benefits and the application of an exogenous land use scenario (see section 4.2). We do not consider any of these issues serious enough to constitute an error or material deficiency in analysis at IBC stage. All four issues have been well communicated to Programme decision makers through the *Programme Short List Options Report, October 2021* and *Preferred Option Report – Modelling Appendix* reports.

We have identified a number of opportunities to refine Programme analysis at the DBC stage, ensuring that final options appraisal results are an accurate representation of viability and relative efficiency. We recommend that DBC planning include the following activities:

1. Dedicated population and Do Minimum modelling well ahead of DBC drafting
2. Alternative air pollutants and GHG scenarios, in line with contemporary Waka Kotahi guidance
3. Calculate returns to Government (BCR-Gs) in addition to standard national benefit calculations (BCR-Ns)
4. Review and agree an appropriate scope for the analysis of Wider Economic Benefits
5. Agree an approach to estimating, collating, and communicating the uncertainty associated with option assessment results

Whilst the *LGWM Programme Preferred Option Report* recommends a preferred Programme option, the full case for investment in the MRT and SHI elements of the programme will be provided in a final IBC, which is due to be completed by the end of 2022. The key next for LGWM options analysis will therefore involve fully document the case for investment across MRT and SHI projects, detailing a final assessment process and proposing how future work could be delivered.



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