ALR Economic Assessment Methodology

WIP Draft

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Security Classification

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Acronyms

Acronym	Definition
AFC	Auckland Forecasting Centre
ALR	The potential network of rapid transit projects currently including City Centre to Māngere, Waitematā Harbour Connections and North West Rapid Transit
ALR	Auckland Light Rail City Centre to Māngere
ALR Ltd	Auckland Light Rail Limited – the company delivering ALR
BCR	Benefit-cost ratio
BCR_g	Government benefit-cost ratio
CAPEX	Capital expenditure
CBA	Cost-benefit analysis
CBC	Corridor Business Case
CC2M Corridor	The land between City Centre and Māngere where urban and transport redevelopment will be delivered by this project
CO2e	Carbon dioxide equivalent
DIA	Distributional impact appraisal
GCs	Generalised costs
HBW	Home based work
M2MPJ	Move to more productive jobs
MBCM	Monetising benefits and costs manual, Version 1.6 (April 2023)
MCA	Multi criteria analysis
MSM	Macro strategic model
NOx	Nitrogen Oxide
LUTI	Land use and transport interaction
OPEX	Operating expenditure
PM10	Particulate matter
QAOI	Qualitative assessment of other impacts
SIA	Social impact appraisal
SO2	Sulphur dioxide
TT	Travel time
VKT	Vehicle kilometres travelled
VOC	Vehicle operating costs

0. Introduction

This document sets out the approach for the economic appraisal of the short-listed options for Auckland Light Rail (ALR) in the Corridor Business Case (CBC). The objective of the economic appraisal is to assess the economic, social, and environmental impacts resulting from the project as well as the costs to provide a value-for-money assessment of proposed options. This assessment has been undertaken in line with Te Tai Ōhanga New Zealand Treasury's Better Business Case Guidance (BBC) and Waka Kotahi New Zealand Transport Agency's Monetised Benefits and Costs Manual (MBCM)[1]. The assessment considers the direct costs and benefits of investment in transport infrastructure provided by ALR, as well as the broader benefits that the project can deliver through land use and lifestyle change over the lifetime of the scheme.

0.1 Document Structure

The assessment encompasses four areas of analysis that are discussed in turn in this document:

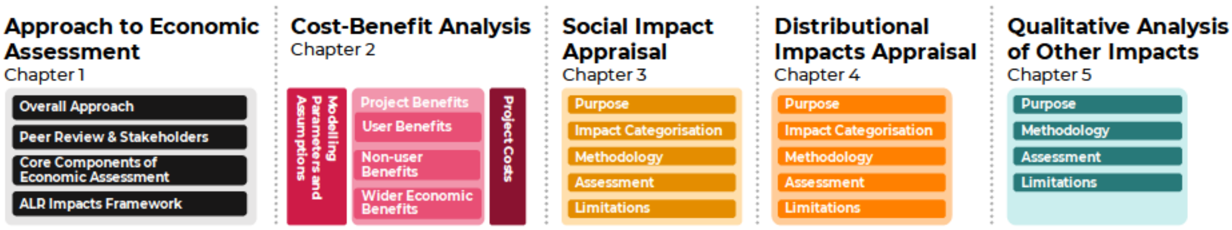
Chapter 1 – Approach to the Economic Assessment: The overall approach to the Economic Assessment including the factors considered as part of the appraisal.

Chapter 2 – Cost-Benefit Analysis (CBA): Quantifies and monetises the user, non-user, and wider economic benefits (WEBs) and specifies how the capital expenditure (CapEx), operating expenditure (OpEx) and revenues associated with project are treated in the CBA.

Chapter 3 – Social Impact Appraisal (SIA): The human experience of the investments in the transport system and urban infrastructure, focusing on Tāmaki Makaurau Auckland's residents, to assess social factors that are not considered in traditional economic appraisals.

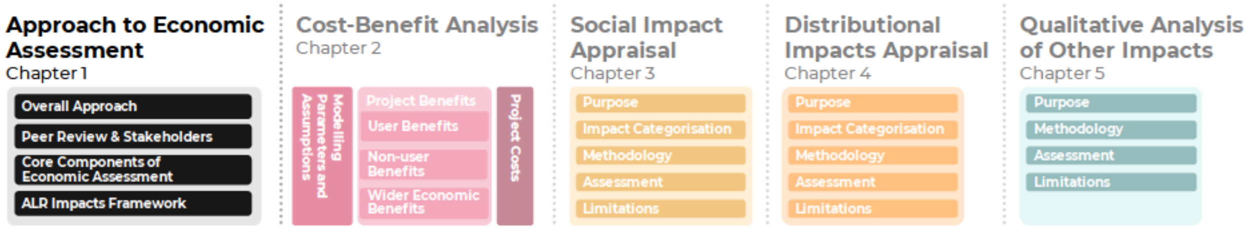
Chapter 4 – Distributional Impact Appraisal (DIA): Identifies the groups that are expected to experience benefits and disbenefits from the transport and urban interventions in the ALR corridor.

Chapter 5 – Qualitative Analysis of Other Impacts (QAOI): The additional impacts that are not monetised and should be considered as part of the appraisal of the Project.



[1] Waka Kotahi NZ Transport Agency (2023), Monetised Benefits and Costs Manual, Version 1.6 (MBCM)

1. Approach to economic assessment



1.1 Overall approach

The economic assessment builds on the appraisal methodology from the Indicative Business Case (IBC) to provide additional robustness and a more comprehensive picture of the benefits of ALR. Additional wider economic, land use, sustainability, and social benefits are now assessed. A social and distributional impacts assessment has also been incorporated into the appraisal to enable a more detailed analysis of the project.

The economic appraisal and value for money assessment is undertaken in line with Waka Kotahi NZ Transport Agency's MBCM. This includes the Land Transport Benefits Framework[2]. Beyond this, the economic case includes innovative approaches to capture impacts that are not covered in the MBCM guidance. This reflects the transformational, wide-reaching nature of the scheme. In some cases, this relies on techniques adapted from the Australian Transport Assessment and Planning (ATAP) Guidelines[3] and UK's Transport Analysis Guidance (TAG)[4]. These have been highlighted throughout the document.

1.2 Peer reviews and stakeholder engagement

The methodology has been prepared with consideration of the peer review of the IBC economic case methodology produced by John Williamson, Director, Ascari Partners. Please see Appendix A for details of this review and the actions taken in response.

The methodology set out in this document has also been reviewed by other key stakeholders as part of an ongoing project engagement and quality assurance process. These include:

- Regular presentations of the Economic Assessment Methodology as part of the Auckland Light Rail Ltd (ALR Ltd) Huihuinga Process attended by officials from NZ Treasury, Ministry of Transport, Ministry of Housing and Urban Development, NZ Infrastructure Commission, Auckland Council and others. This included a deep-dive session at the Huihuinga held on 3rd April 2023.

- External quality assurance review of this methodology through key documents has been undertaken by EY throughout the development of this methodology, beginning in April 2023.

[2] Waka Kotahi (June 2023), Land Transport Benefits Framework measures manual
[3] Transport and Infrastructure Council (2023), The Australian Transport Assessment and Planning (ATAP) Guidelines
[4] UK Department for Transport (2022), Transport Analysis Guidance

- Focused sessions held with NZ Treasury, NZ Infrastructure Commission, NZ Ministry of Housing and Urban Development and the Ministry of Transport on how to measure the impacts of uncertainty in June 2023[5].

1.3 Core components of the economic assessment

The overarching approach to the economic assessment within the Corridor Business Case (CBC) is set out in Figure 1. A separate value for money assessment for each of the core components of the economic assessment has been undertaken, being:

1. the assessment of only the transport elements of the scheme, and
2. The assessment of coordinated urban response options to further enhance the economic rationale for the project as a combined integrated transport and urban investment.

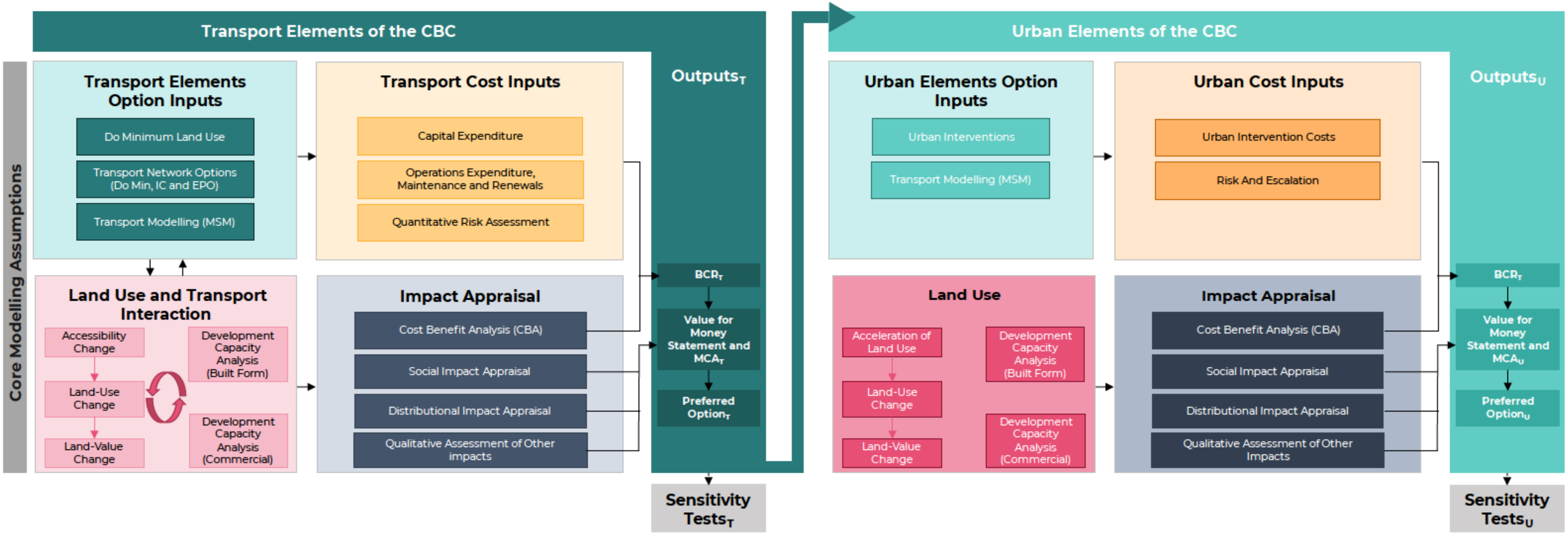
Both the transport and the urban impacts of the Emerging Preferred Option (EPO) are assessed. Only the transport impacts of the Intermediate Comparator (IC) option are assessed, reflecting the capacity of this system to accommodate additional future growth.[6]

Note that the urban elements would only be delivered if the transport elements are delivered. They are dependent on and incremental to the transport investment. A combined assessment for both the transport and urban elements of the EPO is provided to show the overall value for money of the project.

The purpose of this document is to describe the methodology and approach taken to conduct the Impacts Appraisal (see orange boxes in Figure 1) across both the Transport and Urban Economic Assessments. Separate detailed methodologies for the social impact appraisal and the distributional impact appraisal are provided in the full SDI Report, Appendix E-H.

[5] Refer to Appendix E-E Transport Modelling Summary for further details on the methodology to account for impacts of uncertainty.
[6] Refer to Corridor Business Case for details.

Figure 1: Approach to economic assessment in Corridor Business Case



1.3.1 Impacts appraisal

The impacts appraisal is undertaken based on a series of inputs including option definitions, land use assumptions and changes, and cost inputs.

The sub-sections below briefly highlight the key considerations and components within the other core elements of the economic assessment. Subsequent chapters discuss each component of the impacts appraisal in more detail.

Reflecting the direction and scope for the CBC[7]:

- The transport elements are developed to a Detailed Business Case (DBC) level of definition and analysis.
- The urban elements of the CBC are developed to a minimum of an Indicative Business Case (IBC) level of definition and analysis.

Wherever practical, the economic assessment seeks to use the same impact appraisal methodology for both the transport elements and urban elements of the CBC.

1.3.2 Transport elements option inputs

Transport options

Transport options are divided into two categories: the Do Minimum and Do Something:

- Do Minimum: This articulates the expected future state, including land use and transport network outcomes, without ALR. The Do Minimum assumes background growth and the delivery of transport infrastructure schemes that have been committed or are considered likely to happen in the long-term future.[8] No uncommitted transformational transport infrastructure schemes are included. For more details see the Technical Memo on Do Minimum, Appendix E-A.
- Do Something (Transport): This comprises two alternative options, ALR's Emerging Preferred Option (EPO) and the Intermediate Comparator (IC).[9] For more details on these options see Phases 1 and 2 of the Optioneering Report, Appendix E-B.

Transport modelling

Transport modelling and demand forecasting is provided by the Auckland Forecasting Centre (AFC)[10] using the Auckland Macro Strategic Model (MSM), a multi-modal travel demand model for the Tāmaki Makaurau Auckland region. The approach and a description of the model are detailed in the Travel Demand Forecasting Technical Note, Appendix E-E.

1.3.3 Urban elements option inputs

Urban response options

Urban Response options are divided into two categories, Do Minimum and Do Something:

- Do Minimum: The Do Minimum scenario for the urban elements of the CBC is the Do Something (Transport) option from the transport elements assessment. The transport

7 As defined in the Crown Sponsors Expectations Letter to ALR Ltd (7 June 2022)
8 For more details on the Do Minimum please refer to Appendix E-A Do Minimum Report
9 For more information on the two short-listed options please refer to the Optioneering Report, Appendix E-B.
10 Auckland Forecasting Centre

elements of the CBC are a requirement for the delivery of the urban elements (as set out in the introduction to Section 1.3). It is assumed under this Urban Do Minimum option that no additional investment is made in urban infrastructure above the transport elements.

- Do Something (Urban): Two potential Urban Response Options from the Urban Optioneering Process are considered – ALR + Incremental Investment and ALR + Active Investment.[11] These options consist of two levels (the former lower, the latter higher) of urban investment in the ALR corridor above the Urban Do Minimum scenario. Further detail on the on the urban interventions is included in Phase 3 of the Optioneering Report, Appendix E-B. Urban Response options are only considered for ALR – no Urban Response options have been assessed for the Intermediate Comparator.

1.3.4 Land Use and Transport Interaction (LUTI)

Investment in infrastructure (both urban and transport) has an important impact on future land use. LUTI modelling is a top-down analysis of the population and employment demand response to the accessibility changes induced by ALR. LUTI modelling has been undertaken to understand the impact that delivering the ALR scheme will have on land use and land value in Tāmaki Makaurau Auckland.

A detailed methodology for how LUTI modelling is undertaken and how it interacts with transport modelling and the economic assessment is contained in the Land Use Response and Urban Economics Methodology Report, Appendix E-F.[12]

1.3.5 Cost inputs

Costs include the anticipated capital, operating, maintenance and renewal expenditure as well as revenue estimates for each of the transport element and the urban element options.[13]

1.3.6 Economic assessment outputs

Benefit-cost ratio (BCR)

The benefit-cost ratio is a key output of the economic assessment that presents the relative difference between the net present benefits and costs for each of the options assessed. This ratio is calculated for the transport elements of the CBC in isolation (BCR_T) as well as combined BCRs for the transport option with options for coordinated urban interventions (BCR_U).

Value for money (VfM) statement and Multi criteria analysis (MCA)

The VfM statement and multi criteria assessment provide a clear narrative description and appraisal of how the costs, benefits and other impacts considered through the economic assessment support the delivery of the investment objectives as set out in the Investment Logic Map (ILM) established in the strategic case.[14]

The economic assessment extends beyond the monetised analysis of costs and benefits presented in the BCR, to include an assessment of the social, distributional, and other non-monetised impacts. This VfM statement will summarise the key benefits (monetised and non-monetised) and the costs to provide an overall VfM assessment.

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[11] For more information on the two short-listed options please refer to the Optioneering Report, Appendix E-B
[12] See Appendix E-F Land Use and Transport Interaction Modelling
[13] For more details on the Project Cost Inputs please refer to Appendix E-D Shortlist Options Design Summary (including cost estimate report)
[14] For more information on the Investment Logic Map please refer to ALR Strategic Case

Option selection is a balanced judgment encompassing the net present social value (NPSV); the benefit-cost ratio (BCR); the assessment of overall risk (its likelihood, impact, and cost); and decisively important factors such as tourism, foreign/inward investment and socio-economic challenges, the benefit of which is challenging to quantify.

1.3.7 Sensitivity tests

Sensitivity testing is undertaken on key assumptions and inputs to reflect the uncertainty associated with the project and future conditions. This includes testing for uncertainty of benefits and costs based on the key risks to the project. Key sensitivity tests include:

- **Delayed benefits ramp-up:** ALR network demand and the associated benefits ramp up over 10 years rather than an expected 2-year ramp up.
- **High Cost (P95):** Assessing the project using the P95 cost estimate (compared to the P50).
- **Benefit Reduction:** A 20% reduction in benefits across all benefit categories.
- **Benefit Increase:** A 5% increase in benefits across all benefit categories.
- **Increased cost of carbon and low-carbon delivery methods:** A higher value based on The Treasury's CBAx Guidance is attributed to carbon through the whole-life assessment of ALR (approximately double the core assessment value). Realistic opportunities to deliver lower embodied carbon through delivery are incorporated.

1.4 ALR impacts framework

1.4.1 Impacts considered within the impacts appraisal

Table 1 provides an overview of the impacts considered in the economic case across the following chapters:

- Cost-benefit analysis (CBA).
- Social impact appraisal (SIA).
- Distributional impact appraisal (DIA).
- Qualitative assessment of other impacts (QAOI).

The table also shows how the impacts link to the following Key Performance Indicators (KPIs) in the ILM, which connects the impacts to the strategic case:

- KPI 1.1: Increased Residential and Employment Density
- KPI 1.2: Increased Housing and Employment Growth
- KPI 1.3: Improved Quality of Life
- KPI 2.1: Reduced Carbon Emissions
- KPI 2.2: Improved Health Outcomes
- KPI 3.1: Improved Access to Employment, Education & Health Services Across Auckland
- KPI 3.2: Increased Public Transport Capacity
- KPI 3.3: Reduced Travel Times

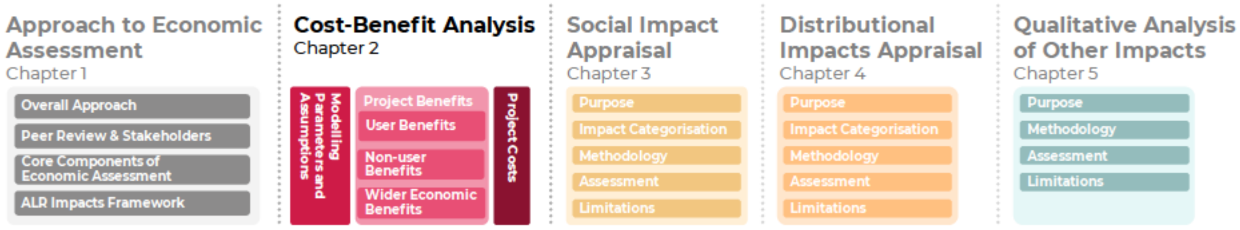
Table 1: All impacts appraised in the economic assessment

Category	#	Impacts	Description	Beneficiaries	Included in MBCM	ALR Investment Logic Map Key Performance Indicators								Qualitative	Quantitative	Monetised	Impacts Appraisal			
						KPI1.1	KPI 1.2	KPI 1.3	KPI 2.1	KPI 2.2	KPI 3.1	KPI 3.2	KPI 3.3				CBA	SIA	DIA	QAOB
User impacts	1	Public transport users travel time savings	Benefits accruing to ALR and other public transport users from reduction in Generalised Costs (GCs), perceived as travel time savings.	PT users	✓								✓	✓	✓	✓	✓		✓	
User impacts	2	Public transport journey reliability	Benefits accruing to public transport users from a more reliable service than the existing service.	PT users	✓			✓			✓	✓		✓	✓	✓	✓			
User impacts	3	Public transport experience	The improvement in quality of facility and service experienced by public transport users.	PT users	✓			✓			✓			✓	✓	✓	✓	✓		
User impacts	4	Active transport (PT users)	The physical and mental health benefits of increased walking and cycling.	PT users	✓			✓		✓				✓	✓	✓	✓	✓		
User impacts	5	Residual asset value	The remaining value of the asset at the end of the appraisal period based on its useful economic life.	PT users and non-users	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓			
User impacts	6	Personal safety	Changes to key security indicators impacting on travellers' personal safety.	PT users	✓			✓			✓			✓				✓		
User impacts	7	Accessibility barriers	Changes to key barriers impacting on accessibility.	PT users	✓			✓			✓			✓	✓			✓	✓	
User impacts	8	Affordability	Changes in personal affordability based on changes in the monetary cost of travel arising from the scheme.	PT users				✓			✓			✓				✓	✓	
User impacts	9	Additional capacity benefits/ future proofing	Benefits associated with making provisions to accommodate future capacity (e.g. extra platform length).	PT users							✓	✓	✓	✓						✓
Non-user benefits	10	Traffic benefits	Benefits accruing to vehicle users from reduction in GCs, comprising perceived travel time savings and vehicle operating costs.	Other road users	✓								✓	✓	✓	✓	✓		✓	
Non-user benefits	11	Road journey reliability	This refers to the impact on the uncertainty/variability in the time taken to travel from the origin to the destination.	Other road users	✓			✓			✓			✓	✓	✓	✓			
Non-user benefits	12	Crash cost savings	Safety benefits associated with reductions in Vehicle Kilometres Travelled (VKT).	Other road users General beneficiaries	✓			✓		✓				✓	✓	✓	✓	✓	✓	

Category	#	Impacts	Description	Beneficiaries	Included in MBCM	ALR Investment Logic Map Key Performance Indicators								Qualitative	Quantitative	Monetised	Impacts Appraisal			
						KPI1.1	KPI 1.2	KPI 1.3	KPI 2.1	KPI 2.2	KPI 3.1	KPI 3.2	KPI 3.3				CBA	SIA	DIA	QAOB
	13	Active transport (primary users)	The physical and mental health impact of active travel by users where active transport is the primary mode.	Active travel users	✓			✓	✓	✓				✓	✓	✓	✓			
	14	Vehicle emissions reduction	Changes in emissions associated with vehicle trips. These includes the impact on Green House Gas (GHG) emissions as well as local air quality.	Wider public	✓			✓	✓	✓				✓	✓	✓	✓		✓	
	15	Embodied and operational carbon	Impact from emissions associated with construction (including enabling infrastructure) and operation of ALR	Wider public				✓	✓	✓				✓	✓	✓	✓			
	16	Other carbon impacts	Carbon impacts of change in lifestyle patterns, embodied emissions from reduced car fleets and active mode trips.	Wider public				✓	✓	✓				✓	✓	✓	✓			
Land use benefits	17	Land value uplift (Rezoning or other land use change)	More productive land use values resulting from rezoning or other land use change.	Landowners		✓	✓							✓	✓	✓	✓			✓
Land use benefits	18	Land value uplift (option/non-use)	This relates to the value that people place in having a public transport option to travel on, even if they don't normally use it. This transport option (or non-use) value is estimated based on land value uplift driven by accessibility changes, adjusted for non-users.	Landowners		✓	✓							✓	✓	✓	✓			✓
Land use benefits	19	Enabling infrastructure cost savings	Increased density and the reduction in urban sprawl enable a more efficient delivery of infrastructure for asset owners and cost savings for asset providers.	Wider public		✓	✓							✓	✓	✓	✓			✓
Wider economic benefits	20	Community severance	Impacts relating to the potential effects of severance resulting from the scheme.	Wider public	✓			✓			✓			✓				✓	✓	
Wider economic benefits	21	Social connectedness	Expected changes in the interactions, relationships and networks that people have with others and the benefits these relationships can bring to the individual and society.	Wider public	✓			✓			✓			✓				✓		
Wider economic benefits	22	Tourism	Increase in tourism due to better connectivity/ accessibility.	Wider public	✓			✓			✓			✓						✓
Wider economic benefits	23	Socio economic challenges	Improvements in social vulnerability levels due to better accessibility to jobs, education, healthcare etc.	Wider public			✓				✓			✓						✓

Category	#	Impacts	Description	Beneficiaries	Included in MBCM	ALR Investment Logic Map Key Performance Indicators								Qualitative	Quantitative	Monetised	Impacts Appraisal			
						KPI1.1	KPI 1.2	KPI 1.3	KPI 2.1	KPI 2.2	KPI 3.1	KPI 3.2	KPI 3.3				CBA	SIA	DIA	QAOB
	24	Disruption from construction/ implementation	The costs/impacts which may occur due to construction/implementation of ALR	Wider public	✓									✓						✓
	25	Foreign/ inward investment	Good transport infrastructure and positive changes accessibility/improved supply chain may encourage international investors to invest in the region.	Business owners			✓				✓			✓						✓
	26	Jobs from construction	Job creation associated with construction	Job seekers			✓							✓	✓					✓
	27	Agglomeration	Productivity gains that arise when increased spatial concentration results in higher efficiency of activities.	Business owners	✓	✓	✓				✓			✓	✓	✓	✓			
	28	Imperfect competition	Impact of transport infrastructure induced increases in output in sectors with price cost margins.	Wider public	✓						✓			✓	✓	✓	✓			
	29	Increased labour supply	Additional tax revenue due to increases in the supply of labour associated with improved transport infrastructure.	Wider public	✓	✓	✓				✓			✓	✓	✓	✓			
	30	Move to more productive jobs	Additional tax revenue resulting from workers moving to more productive jobs because of improved transport infrastructure.	Wider public		✓	✓				✓			✓	✓	✓	✓			

2. Cost-benefit analysis (CBA)



2.1 CBA modelling parameters and assumptions

Table 2 outlines the assumptions and parameters applied within modelling calculations. These have been drawn from a range of guidance documents.

Table 2: Key model assumptions

Element	Value	Unit	Notes / Source
Modelling parameters			
Discount rate (real)[15]	4%	*% real*	Aligned with MBCM
Discount year	2022	*year*	
Price base	$2022	*date*	Aligned with MBCM
Escalation factors	As defined by MBCM Other escalation factors used for: Carbon emissions cost Public transport fare revenue	*factor*	*Update factors for benefits:* MBCM *Cost update factors:* MBCM *Other escalation factors:* CBAx Tool, NZ Treasury StatsNZ Consumer Price Index
Demand growth and capping	Growth based on interpolation of benefits between modelling years and extrapolation of benefits from the last modelling year 2065 capped by capacity.		Aligned with MBCM. Demand is capped based on an extrapolation of the overall system demands from 2065 and the capacity of each system. Where demand cap is reached, benefits remain constant.
Benefits ramp up	As defined by the proposed staging of the different options assessed.[16]		ALR Assumption based on an initial assessment of the impacts of staging.[17]

[15] The real discount rate reflects the long-term opportunity cost of capital as well as the rate at which society is willing to trade off present benefits and costs against future benefits and costs.
[16] For more information on the two short-listed options please refer to Phase 1 and 2 of the Optioneering Report, Appendix E-B.
[17] As the AFC MSM directly provides the benefits instead of demand numbers, the benefit ramp up actually reflects an expected demand ramp up over time to show that full demand is not realised from the opening day of ALR.

Element	Value	Unit	Notes / Source
Project timeline inputs			
Appraisal start date	2022	*year*	Aligned with MBCM
Construction start date	As defined by the proposed staging of the different options assessed.[18]		ALR Assumption
Operations start	As defined by the proposed staging of the different options assessed.[18]		ALR Assumption
Appraisal period	Construction period and 60 years of operations		Option within MBCM[19]
Transport modelling assumptions			
Transport modelling years	2031, 2041, 2051 and 2065	*years*	AFC MSM model years
Annualisation factors			
Weekdays per year	245	*days*	MSM model
Weekend/holidays per year	120	*days*	MSM model
Public transport day to year factor	279	*days*	AFC recommended practice[20]

2.2 Project benefits

To enable a comprehensive and robust assessment of benefits from the project, three categories of benefits have been estimated in line with MBCM guidance: user benefits, non-user benefits and wider economic benefits.

Benefits are calculated using outputs from AFC's MSM and based on the methodology provided in the MBCM, unless stated otherwise.

The following sections provide details on the inputs and parameters from MBCM used in the benefits calculations. The complete methodology is not listed within this paper unless there are specific adjustments to the MBCM 1.6 methodology. The benefits are calculated by comparing the Do Something options with the Do Minimum option. The difference between the two scenarios is used to calculate the benefits associated with each option.

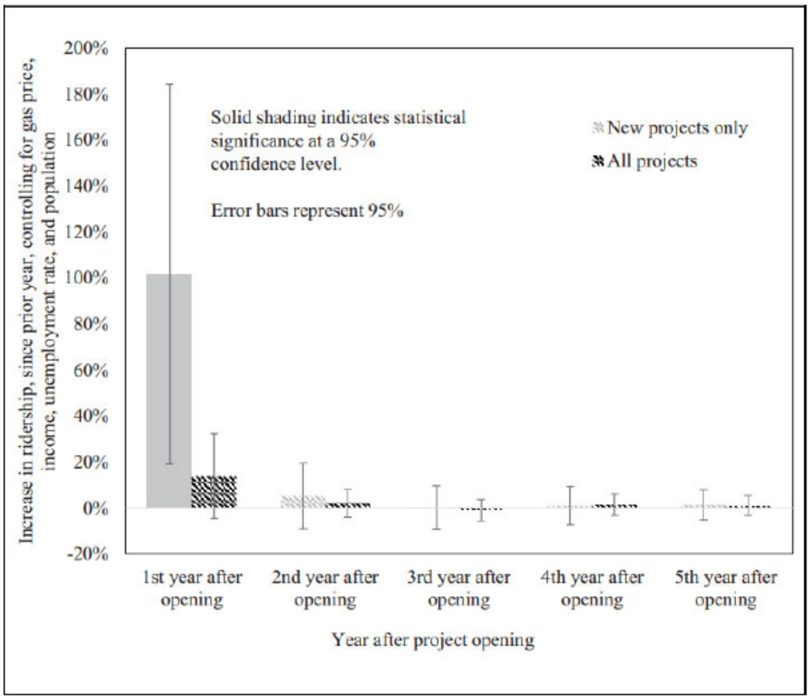
2.2.1 Benefits ramp-up

The benefits from the transport investment are not expected to be fully realised from the opening day of operations. Given the benefits of such a scheme are largely linked to a change in travel behaviour (people changing transport mode) and changes in land use (intensification) around the corridor, it follows that benefits from the scheme will ramp-up over time.

18 For more information on the two short-listed options please refer to Phase 1 and 2 of the Optioneering Report, Appendix E-B.
19 Aligned with the standard approach for projects of this nature recommended by UK TAG and ATAP guidelines, based on the assumed economic life of rail infrastructure.
20 Based on Auckland Transport HOP data

The economic model assumes a two-year benefit ramp-up periods, based on previous experience in Tāmaki Makaurau Auckland as well as academic literature. A research study[21] of 55 rail transit projects in the United States which looked at ridership in the initial years after project opening found a significant increases in ridership in the first 2 years after project opening as depicted in Figure 2 below.

Figure 2: Expected increase in ridership by year after project opening
(Evaluation of 55 transit projects in the US)



For ALR and the Intermediate Comparator, Table 3 and
Table 4: benefit ramp up assumption for Intermediate Comparator below showcases the benefit ramp-up assumed for each option.

Table 3: Benefit ramp up assumption for ALR

Year	Proportion of benefits	Comments
July 2032	12.1%	2-year ramp-up with 50% of benefits in year 1
July 2033	24.3%	
July 2034	32.2%	2-year ramp-up from stage 2 opening to full stage 2 patronage
July 2035	40.0%	
July 2036	70.0%	2-year ramp-up
July 2037	100.0%	

Table 4: benefit ramp up assumption for Intermediate Comparator

Year	Proportion of benefits	Comments
July 2034	50%	2-year ramp up with 50% of benefits in year 1

[21] Shinn, J. E., & Voulgaris, C. T. (2019). Ridership Ramp-Up? Initial Ridership Variation on New Rail Transit Projects. Transportation Research Record, 2673(10), 82-91. https://doi.org/10.1177/0361198119844462

July 2035	100%	2-year ramp up with 100% of benefits in year 2

2.2.2 User benefits

User benefits refer to benefits that will accrue directly to the users of the transport investment and include those shown in Table 5, which are explained in more detail below.

Table 5: User benefits assessed in the economic appraisal

Category	#	Impacts	Description	Included in MBCM	KPI 1.1	KPI 1.2	KPI 1.3	KPI 2.1	KPI 2.2	KPI 3.1	KPI 3.2	KPI 3.3
User impacts	1	Public transport users travel time savings	Benefits accruing to ALR and other public transport users from reduction in Generalised Costs (GCs), perceived as travel time savings.	✓								✓
	2	Public transport journey reliability	Benefits accruing to public transport users from a more reliable service than the existing service.	✓			✓			✓	✓	
	3	Public transport experience	The improvement in quality of facility and service experienced by public transport users.	✓			✓			✓		
	4	Active transport (PT users)	The physical and mental health benefits of increased walking and cycling.	✓			✓		✓			
	5	Residual asset value	The remaining value of the asset at the end of the appraisal period based on its useful economic life.	✓	✓	✓	✓	✓	✓	✓	✓	✓

2.2.2.a Public transport users travel time savings

Public transport (PT) user travel time savings are benefits accruing to ALR users (existing public transport users, new public transport users who have transferred from another mode and new generated trips) from reductions in generalised costs (GCs), expressed in minutes. Generalised cost/time is the sum of the monetary and non-monetary components of a trip (both monetary costs, time, crowding and interchange penalties) across all modes.

Methodology

The calculation for travel time savings complies with section 3.6 of the MBCM guidance which suggests that "the travel time benefits for a project option shall be calculated as the difference between the Do Minimum and option travel time costs". Travel time savings apply to both existing users and new users. The formula for the benefit calculation is as shown in Equation 1.

Equation 1: Public transport users travel time savings

$$\textit{Travel time savings for existing public transport users} = D_m * (GC_m - GC_o)$$

$$\textit{Travel time savings for additional public transport users} = 0.5 * (D_o - D_m) * (GC_m - GC_o)$$

Where:

- D_m is Do Minimum PT demand, where PT is trip by purpose.
- D_o is project option PT demand, where PT is trip by purpose.
- GC_m is Do Minimum generalised cost.
- GC_o is project option generalised cost.

As per MBCM, “new trips generated or induced as a result of travel time savings for existing traffic shall be assessed at half the benefits from travel time saving per vehicle for existing traffic”. This is the rule of half which is applied to transport system users who change their travel behaviour to switch to public transport and are part of the new public transport demand. The approach is consistent with the analysis done at IBC level, which was peer reviewed.

However, the AFC MSM macro applies the rule of half to all PT benefits, when it should be applied only to the car users shifting to PT. Therefore, the inputs received from AFC are corrected using Equation 2. The proportion provided by equation 2 is multiplied by the AFC MSM PT benefits and then divided by half to estimate the benefits for existing users.

Equation 2: Public transport users trave time savings rule of half correction

$$Rule\ of\ a\ half\ Correction\ Factor = Reduction\ in\ bus\ \text{trips}\ (Do\ Min - option) \div ALR\ \text{trips}\ (Option - do\ Min)$$

PT benefits are monetised based on the equalised value of time parameters provided in MCBM for the various trip purposes extracted from the model. The table below sets out the key input values used to monetise the PT benefits.

Table 6: Inputs used to monetise public transport user benefits

Element	Value	Unit	Notes / Source
Value of time, work travel	*See source*	*$/hour/person*	MBCM
Value of time, commuting to/from work	*See source*	*$/hour/person*	MBCM
Value of time, other non-work travel purpose	*See source*	*$/hour/person*	MBCM
Equivalent factors[22]			
AM (daily factor, PT person)	1.00	*Factor*	AFC MSM model setup
PM (daily factor, PT person)	1.00	*Factor*	AFC MSM model setup
Weekday IP (daily factor, PT person)	5.26	*Factor*	AFC MSM model setup
Weekend / holiday (daily factor, PT person)	5.40	*Factor*	AFC MSM model setup
IP (daily factor, PT person)	7.90	*Factor*	Calculation

2.2.2.b Public transport journey reliability

Public transport journey reliability benefits refer to impacts accruing to public transport users resulting from a more reliable service than the existing service. For a public transport journey, reliability can affect users in two ways:

- As a delay before joining the service, relative to the expected arrival/departure time, and
- As a delay when the passenger is on the service.

Anticipated journey reliability can impact an individual’s desired trip-making behaviour, for example by catching earlier services to get to their destination on time. An improvement in

[22] The equivalent factors in the table above represent the MSM modelled peak to daily expansion factors required to calculate the overall annual demand on the network. This is because the transport modelling is undertaken for three periods – AM, PM, and inter-peak (IP) wherein each period includes 2 hours.

journey reliability generates a benefit to users in perceived time savings and/or through the creation of demand for the service.

Methodology

The methodology is outlined below:

1. General transit feed specification (GTFS) real time data of Auckland Transport's bus network movements from March 2019 is analysed across the AM, IP, and PM periods.
2. An overall reliability metric is developed by comparing both the absolute minutes late to a specific stop (i.e., both arriving earlier or later than expected) and the runtime delay while on the service.
3. A select link analysis is performed across the ALR corridor to assess the current and projected typical public transport travel patterns for expected users of the light rail network.
4. The reliability metric for the routes/corridor segments and time periods of interest is computed.
5. The reliability metric is then mapped for each route/corridor segment.
6. Benchmark reliability level for future light rail service is determined in each stage of implementation.
7. The difference between current and future variability is applied to the modelled demand for each segment of the light rail corridor to estimate the economic benefit for each stage based on the equivalent in vehicle times prescribed in MBCM.
8. March 2019 data is used to align with the MSM model, which uses census forecasts (collected in March) to inform travel demand modelling. 2019 data was chosen (compared to more contemporary data) to reflect anticipated travel patterns, recognising the disruption to travel since COVID-19. Separate changes to work from home patterns within the transport model have also been applied to separately reflect overall changes in travel demand.

With regards to the IC surface light rail scheme, a simplified approach was taken to calculating the public transport journey reliability benefits. The methodology is as follows:

1. Using the results for the EPO, calculating the proportion of public transport journey reliability benefits relative to overall public transport user travel time savings (by model year).
2. Calculating the unadjusted journey reliability benefits for the IC using actual public transport user travel time savings and the proportion calculated in step 1.
3. Recognising that a surface light rail scheme is more susceptible to disruption, reduce the IC journey reliability benefits by a factor of 0.897[23].

Limitations

This method only examines the benefits of people travelling from or to CC2M station locations, along paths that run near to the expected station location. Reliability benefits may

[23] Factor based on actual journey reliability of comparable surface light rail scheme in Manchester, United Kingdom (KeolisAmey Metrolink Performance 24 July to 10 December 2022): https://assets.ctfassets.net/nv7y93idf4jq/hwlwSOop3mrzNtzYz1Off/2d5847c54eba84f3ea2365123a8f766d/Performance_Poster_24_July_to_10_Dec_2022.pdf

accrue in other areas of the network, but these are assumed to be negligible in comparison to those along the corridor.

The approach uses MSM outputs, which is a fixed demand model that does not capture additional reliability benefits through the creation of new trip demand. There is potential that the improved service may induce additional demand, which has not been assessed or monetised.

Assumptions on the future reliability of bus routes is based on existing reliability data, and modified where new infrastructure (e.g. bus lanes) will be delivered. This does not consider any potential change in prevailing conditions across the corridor (for example, the city centre), which may influence the overall impact.

As a result of these factors, the calculation made might underestimate the overall benefit of PT journey reliability.

2.2.2.c Public transport experience

ALR will result in public transport users experiencing an improved quality of facility and service. These benefits are generally related to the level of comfort provided by the new intervention.

Methodology

Public transport users value infrastructure and in-vehicle features. Typical user valuations expressed in terms of in-vehicle time (IVT) are outlined in the MBCM for each attribute. The IVT for each of these attributes are then converted to generalised costs by multiplying the value of time given in the MBCM. A weighted average of the value of time is used for this calculation, which is based on the total PT trip-by-trip purpose multiplied by value of time in the MBCM dependent on trip type.

Perceived benefits of multiple features are less than the sum of individual components. Therefore, to avoid overestimation, the total value of benefits is divided by two as shown in Table 7 below.

Table 7: Vehicle feature values for public transport services

Element	Value	Unit	Notes / Source
PT experience value (adjusted for overestimation)	7.05	IVT minutes	Based on sum of MBCM values for different elements of PT experience and adjusted for overestimation.

Limitations

The values for all amenities considered above based on the guidance from MBCM may not capture the full extent of amenity benefits once all urban interventions are considered, aimed at improving place-making around station locations.

2.2.2.d Active transport benefits (PT users)

Active transport benefits refer to the physical and mental health benefits of additional walking and cycling undertaken by new users of public transport to get to and from a public transport stop.

Methodology

This benefit is estimated by using the MSM output on the number of kilometres walked per day by users to access PT in the Do Minimum and project options scenarios. The difference between the two scenarios provides the change in walking kilometres, which is then monetised by applying the standard MBCM rates for walking km to convert km into benefits.

In accordance with MBCM guidance, overall active transport benefits per year are capped based on the number of new users of public transport.

Table 8: Inputs used to estimate active travel benefits

Element	Value	Unit	Notes / Source
Monetised values			
Walking	*See source*	$/km	MBCM
Walking (maximum annual benefit)	*See source*	$/person	MBCM
Electric-assisted cycling	*See source*	$/km	MBCM
Electric-assisted cycling (maximum annual benefit)	*See source*	$/person	MBCM

Limitations

Access around specific key station nodes is expected to improve because of the investment in ALR. To recognise this, improved accessibility to these stations has been modelled in the MSM[24].

The allocation of costs associated with improved accessibility may not be fully recognised in the overall costing of the transport elements. To avoid the potential of counting benefits without equivalent costs, all active mode benefits associated with access to these key stations have not been included when assessing the transport elements only.

The urban interventions considered under the urban options have specific costs attributed to station accessibility, incorporating a variety of active modes (being improved walking, cycling and micro mobility facilities). A conservative estimate of health benefits based on the electric-assisted cycling parameters in the MBCM has been used to monetise these benefits.

Both assumptions may result in a conservative estimate of overall active mode benefits for the transport elements only.

2.2.2.e Residual asset value

Residual asset value refers to the value of the proposed asset based on its remaining useful economic life. The MBCM recommends that the residual value of assets is explicitly calculated as part of the cost estimation of projects in its guidance. The guidance also recommends that an appraisal period covers at least 90% of the benefits. Residual asset value can be a proxy for remaining benefits beyond the appraisal period. Rail infrastructure has a long operating life, with tunnels being recognised as having a useful life in excess of 75 years [25].

Methodology

The Australian Transport Assessment and Planning (ATAP) guidance provides a methodology for assessing this residual value based on a straight-line depreciation of capital costs which has been adopted. This methodology used is as follows:

[24] Further details on improved accessibility can be found in Appendix E-E Transport Modelling Summary
[25] KiwiRail Annual Report. 2022. https://www.kiwirail.co.nz/assets/Uploads/documents/Annual-reports/2022/KiwiRail-Integrated-Report-2022.pdf (retrieved May 2023)

Estimated useful economic life of each asset class → Straight-line depreciation for each asset to understand residual value at the end of the appraisal period → Discount the residual value to the last appraisal year

Only assets that have a 100-year useful life (or greater) are included in the assessment of residual asset value.

Table 9: Assumptions used to estimate residual asset value

Element	Value	Unit	Notes / Source
Residual Asset Value			
Economic life of relevant asset types	100	*years*	Refer to Appendix E-D Shortlist Options Design Summary (including Cost Estimate Report) for details of which asset types have a 100-year asset life for inclusion in residual asset value calculations

2.2.3 Non-user benefits

Non-user benefits refer to benefits that will accrue to those who will not use ALR but will benefit from the project outcomes. This includes users of other modes, and the wider population. This includes the benefits listed in Table 10 below and explained in more detail in the following sub sections.

Table 10: Non-user benefits assessed in the economic appraisal

Cat	#	Impacts	Description	Included in MBCM	KPI1.1	KPI 1.2	KPI 1.3	KPI 2.1	KPI 2.2	KPI 3.1	KPI 3.2	KPI 3.3
Non-user impacts	10	Traffic benefits	Benefits accruing to vehicle users from reduction in GCs, comprising perceived travel time savings and vehicle operating costs.	✓								✓
	11	Road journey reliability	This refers to the impact on the uncertainty/variability in the time taken to travel from the origin to the destination.	✓			✓			✓		
	12	Crash cost savings	Safety benefits associated with reductions in Vehicle Kilometres Travelled (VKT).	✓			✓		✓			
	13	Active transport (primary users)	The physical and mental health impact of active travel by users where active transport is the primary mode.	✓			✓	✓	✓			
	14	Vehicle emissions reduction	Changes in emissions associated with vehicle trips. These includes the impact on Green House Gas (GHG) emissions as well as local air quality.	✓			✓	✓	✓			
	15	Embodied and operational carbon	Impact from emissions associated with construction (including enabling infrastructure) and operation of ALR				✓	✓	✓			
	16	Other carbon impacts	Carbon impacts of change in lifestyle patterns, embodied emissions from reduced car fleets and active mode trip generation.				✓	✓	✓			

2.2.3.a Traffic benefits

Traffic benefits are accrued by vehicle users from a reduction in Generalised Costs (GCs) including travel time, perceived congestion, and perceived vehicle operating costs for residual road users, as a result of others transferring to PT.

Methodology

The traffic benefits are calculated by AFC directly from the MSM which compares each option against the Do Minimum scenario. A full technical note is being prepared by AFC for submission with the CBC. The calculations are outlined as follows:

- **Travel time savings:** The vehicle time for each trip purpose extracted directly from the MSM, to obtain the total person minutes. The sum of these minutes travelled is calculated for the Do Minimum and each project option individually. The difference between the two is the travel time savings benefit.
- **Perceived congestion costs:** This refers to the relief from congestion traffic conditions which is over and above the value of travel time savings. AFC has developed a specific macro to calculate these benefits based on the methodology specified in the MBCM.
- **Perceived vehicle operating costs (VOC):** This refers to changes in the cost of fuel, tyres, repairs and maintenance, oil, and depreciation. VOC, for each link in the MSM, is comprised of three segments as set out in the MBCM:
    - Base VOC.
    - Additional VOC due to congestion.
    - Additional VOC due to bottleneck.

  Each of the three segment values are based on vehicle class rather than road category. MSM models two classes—under 3.5t (light) and over 3.5t (heavy). VOC values for light and heavy have been generated using values prescribed in the MBCM.
- **Resource cost correction:** The resource cost correction accounts for the proportion of the perceived costs to users which are actually a transfer between an individual user and the government (like Goods and Services Tax (GST). Overall traffic benefits are calculated by adding the resource cost correction to each benefits using the process specified in the MBCM.

The traffic benefits and VOC costs are monetised based on the value of time in the MBCM for the various trip purposes extracted from the model. The key input values used in the calculation of the benefit are set out in Table 11 below.

Table 11: Value of travel time and equivalent factors for road users

Element	Value	Unit	Notes / Source
Work travel purpose	*See source*	*$h/person*	MBCM
Commuting to/from work	*See source*	*$h/person*	MBCM
Other non-work purpose	*See source*	*$h/person*	MBCM

Element	Value	Unit	Notes / Source
Value of time, heavy commercial vehicle II	*79.93*	*$/hour/vehicle*	Calculation based on MBCM values[26]
Equivalent factors[27]			
AM (daily factor, vehicles)	1.00	*Factor*	AFC MSM model setup
PM (daily factor, vehicles)	1.00	*Factor*	AFC MSM model setup
Weekday IP (daily factor, vehicles)	5.42	*Factor*	AFC MSM model setup
Weekend / holiday (daily factor, vehicles)	6.50	*Factor*	AFC MSM model setup
IP (daily factor, vehicles)	8.60	*Factor*	Calculation

2.2.3.b Road journey reliability

An intervention in one part of the network may reduce the variability in another part of the network, resulting in an overall increase in journey time reliability for vehicles.

Methodology

The methodology used is in line with section 3.7 of the MCBM which lists the following steps to calculate road journey reliability benefits. AFC directly calculates the road journey reliability benefits by:

1. **Calculate the standard deviation** of travel time on by assessing the volume to capacity ratios on each link for each origin and destination pair, across each time period, using the formula provided in the MBCM.
2. **The variance of all journey times** is calculated by aggregating this link analysis, following steps 2 to 5 specified in the MBCM.
3. **Calculate the difference in variability** between the project and Do Minimum networks to evaluate the total minutes saved from reduced network variability.
4. **Calculate the impact of changes in trip reliability** using the formula outlined in Equation 3.

Equation 3: Impact of changes in road journey trip reliability

0.9 × travel time value ($/h)
× (reduction in the network variability (in min) / 60)
× traffic volume for time period (veh/h)

Where: The reduction in network variability is the difference between the sums of the variability for all journeys in the modelled area for the Do Minimum and project option. The 0.9 factor is the value of reliability based on a typical urban traffic mix (as specified in the MBCM).

No correction factor is applied because the analysis of journey reliability is conducted using a regional transport model (as specified in the MBCM).

[26] Calculation based on MBCM values for different commercial vehicle types and the traffic composition for the same.
[27] The equivalent factors in the table above represent the MSM modelled peak to daily expansion factors required to calculate the overall annual demand on the network. This is because the transport modelling is undertaken for three periods – AM, PM, and inter-peak (IP) wherein each period includes 2 hours.

2.2.3.c Crash cost savings

ALR will reduce the overall volume of vehicle kilometres travelled (VKT) on the road network and lead to an increase in PT usage. This will result in a decrease in the number of crashes as a trip on a PT service has an overall lower safety risk than a comparable trip by a vehicle, thus leading to safety benefits.

Methodology

The AFC MSM directly outputs an estimate of the number of crashes associated with the Do Minimum and the assessed project options by different road types (such as rural, urban and motorways). A comparison of the Do Minimum and project options difference gives an estimate on the number of crashes avoided.

The reduction in crash estimates is monetised using the crash cost values from MBCM given for accidents in different road environment as shown in the table below.

Table 12: Crash cost values for different road environment

Element	Value	Unit	Notes / Source
Urban crash cost	*See source*	$/crash	MBCM
Rural crash cost	*See source*	$/crash	MBCM
Motorway crash cost	*See source*	$/crash	MBCM

Limitations

The approach does not consider the risks to the safety of additional active travel users and PT users. This is qualitatively caveated in the economic appraisal.

2.2.3.d Vehicle emissions

The improved travel time reliability, service frequency and user experience of ALR will lead to a shift in travel from private vehicles to public transport. This will result in a reduction in transport emissions associated with fewer private vehicles on the road.

The reduction in emissions in the Do Something options compared to the Do Minimum scenario is likely to decrease over time as the use of electric vehicles increases. As a result, the extrapolation of vehicle emission reductions beyond the last modelling year will result in an increase in vehicle fuel-related emissions (which is not realistic when considering electric vehicles).

To control for this, vehicle emissions are adjusted so that, once benefits reach zero for fuel related emissions, they remain zero in subsequent years (and do not turn negative, which would represent an increase in emissions). This is not the case for tyre-related emission reductions which are expected to remain positive throughout the appraisal period.

Methodology

The change in emissions calculation is based on direct MSM outputs, showing CO_2e, PM10, NO_x, CO, SO_2 and VOC emissions associate with the Do Minimum and project options in kg/day. The change in emissions is then monetised using values from the MBCM guidance as given in the table below. A higher value of CO_2e is considered in the sensitivity tests.

Table 13: Emission values

Element	Value	Unit	Notes / Source
$PM_{2.5}$ cost	*See source*	$/tonne	MBCM
NO_X cost	*See source*	$/tonne	MBCM
SO_2 cost	*See source*	$/tonne	MBCM
VOC cost	*See source*	$/tonne	MBCM
CO_2e cost	*See source*	$/tonne	Central values provided in both CBAx Tool User Guidance, NZ Treasury and MBCM.
Emissions annualisation factor	*329*	*factor*	Assumption. Average annual daily travel assumed to represent 90% of average daily travel from MSM.

2.2.3.e Embodied and operational carbon costs

The full accounting of carbon emissions from the project needs to be understood and monetised. This will include:

- Embodied emissions of the transport infrastructure (disbenefit).
- Operational carbon emitting from the scheme (disbenefit).

Full details of the methodology for assessing embodied and operational carbon impacts is included in the Carbon Methodology and Assessment Report, Appendix E-I.

2.2.3.f Other carbon impacts

This will include the assessment of the following impacts:

- Emissions savings from changes in lifestyle patterns, focusing on differences in enabling infrastructure and built form emissions of greenfield and brownfield development.
- Additional emissions savings associated with reduced energy consumption from electric vehicles through mode shift.
- Embodied vehicle emissions savings from reduced car fleets.

Full details of the methodology for assessing other carbon impacts is included in the Carbon Methodology and Assessment Report, Appendix E-I.

2.2.4 Land use benefits

Land use benefits refer to benefits that result from more efficient or productive land uses. This includes the benefits listed in Table 14 below and explained in more detail in the following sub sections.

Table 14: Land use benefits assessed in the economic appraisal

Cat	#	Impacts	Description	Included in MBCM	KPI1.1	KPI 1.2	KPI 1.3	KPI 2.1	KPI 2.2	KPI 3.1	KPI 3.2	KPI 3.3
Land use benefits	17	Land value uplift (Rezoning or other land use change)	More productive land use values resulting from rezoning or other land use change.		✓	✓						
	18	Land value uplift (option/non-use)	This relates to the value that people place in having a public transport option to travel on, even if they don't normally use it. This transport option (or non-use) value is estimated based on land value uplift driven by accessibility changes, adjusted for non-users.		✓	✓						
	19	Enabling infrastructure cost savings	Increased density and the reduction in urban sprawl enable a more efficient delivery of infrastructure for asset owners and cost savings for asset providers.		✓	✓						

2.2.4.a Land value uplift (rezoning or other land use change)

Improvements in transport accessibility are likely to lead to increased land values, as stated in the MBCM guidance[28]. This specific benefit referred to as higher value land use consists of the rezoning land value uplift, while holding accessibility improvements (like improved journey times) fixed, to avoid double-counting with the transport user benefits. It only relates to the value of additional development resulting from project induced land use change and it represents an additional benefit.

Methodology

Higher value land use impact is assessed through the use of LUTI Consulting's Greater Auckland hedonic land price model (HPM). This is a statistical model that can be used to predict land values, or changes in land values, based on a wide range of land attributes. More information on LUTI Consulting's methodology is available in a separate report[29].

2.2.4.b Land value uplift (option/non-use)

Option or non-use value refers to the value that individuals with uncertain demand place on a transit investment over and above their expected user benefit. While the MBCM guidance does not include option values or provide a methodology for estimating these, a previous research study by the Waka Kotahi in 2012[30] recommended the inclusion of option values as an additional benefit reflecting individuals' willingness to pay for the option of having a new transport service available.

Methodology

Transit option value is calculated through the use of the Greater Auckland Hedonic Price Model.

The rationale for this benefit estimation approach is that the proximity benefits of LRT stations get monetised into land values despite not all travel by residents proximate to those stations being by LRT. Residents choosing to live near an LRT station do not have a choice of paying the premium for locating there as the market sets the price. Thus, the premium that residents pay to located near an LRT stop is considered an option value if they are not users of the infrastructure.

[28] See section 1.7 of the MBCM.
[29] See Appendix E-F Land Use and Transport Interaction Modelling
[30] Waka Kotahi (2012), Research Report 471 The benefits of public transport – option values and non-use values

More information on LUTI Consulting's methodology is available in a separate report[31].

2.2.4.c Infrastructure cost savings

Infrastructure and cost savings are potential benefits that can be accrued by facilitating greater rates of urban infill over the alternative of greenfield expansion (or urban sprawl). Cost savings arise through more efficient provision of infrastructure, like water, power or sewerage.

Methodology

Benchmark infrastructure costs for brownfield (within the ALR corridor) and greenfield development have been calculated based on an assessment of current infrastructure provision within the corridor, and publicly available data on other projects.

By classifying MSM zones as predominately brownfield or greenfield, cost savings are calculated based on the changes in overall land use across the region. To ensure a consistent substitution of residents between brownfield and greenfield areas, a uniform household size is used to avoid misrepresentation of the savings.

More information on quantifying the incremental infrastructure costs associated with ALR's induced land use change is provided in Phase 3 of the Optioneering Report, Appendix E-B. More information on calculating these savings is provided in a separate report[32].

2.2.5 Wider economic benefits

Wider economic benefits (WEBs) are additional to transport user benefits and are therefore quantified separately. WEBs include impacts on productivity, employment, and economic output, considering the full welfare impact of a transport intervention. This includes factors which may not be captured in the transport market due to failures in other markets, such as labour and land markets.

As per MBCM 3.9, "generally, these would need to change the distribution or density of households and firms within a major metro area, or deliver significant improvements in accessibility between regions, in order for wider effects to arise". The assessment of WEBs is undertaken with the assumption of a dynamic land use change, that is, assuming a land use response because of changes to transport accessibility resulting in spatial changes to employment (consistent with MBCM guidance).

More information on LUTI Consulting's methodology for calculating land use change is available in a separate report[33].

Table 15 lists out all WEBs assessed as part of this economic appraisal. These are explained in more detail in the following sub sections. While the first three impacts – agglomeration, imperfect competition and increased labour supply – are based on MBCM guidance and were included in the IBC, this methodology has included a new type of WEB based on international best practice. Movement to more productive jobs is mentioned in the MBCM guidance, although no specific method to calculate this benefit is provided.

[31] See Appendix E-F Land Use and Transport Interaction Modelling
[32] See Appendix E-F Land Use and Transport Interaction Modelling
[33] See Appendix E-F Land Use and Transport Interaction Modelling

Table 15: Wider economic benefits assessed in the economic appraisal

Cat	#	Impacts	Description	Included in MBCM	KPI1.1	KPI 1.2	KPI 1.3	KPI 2.1	KPI 2.2	KPI 3.1	KPI 3.2	KPI 3.3
Wider economic benefits	27	Agglomeration	Productivity gains that arise when increased spatial concentration results in higher efficiency of activities.	✓	✓	✓				✓		
	28	Imperfect competition	Impact of transport infrastructure induced increases in output in sectors with price cost margins.	✓						✓		
	29	Increased labour supply	Additional tax revenue due to increases in the supply of labour associated with improved transport infrastructure.	✓	✓	✓				✓		
	30	Movement to more productive jobs	Additional tax revenue resulting from workers moving to more productive jobs because of improved transport infrastructure.		✓	✓				✓		

2.2.5.a Agglomeration

Agglomeration benefits measure the productivity gains that arise from improved connectivity and increased spatial concentration of economic activity. The assessment calculates dynamic agglomeration benefits, assuming land use changes which translate into changes in employment by transport model zone. It assumes that the Do Something options and associated dependent land use changes take place.[34]

Methodology

Agglomeration benefits are calculated for each modelling year based on outputs from the MSM produced by AFC, economic data, and parameters from the MBCM as set out in the table below. Dynamic land use changes are calculated based on LUTI modelling.

Table 16: Inputs used to estimate agglomeration benefits

Element	Values	Unit	Notes / Source
Do Min GCs for car and PT (work travel, commuting)	Various, see source	*$*	AFC MSM model[35]
Project Option GCs for car and PT (work travel, commuting)	Various, see source	*$*	AFC MSM model
Do Min employment by model zone and by sector	See notes/source	*Jobs per model zone and sector in each modelling year*	AFC MSM model
Project Option Employment by model zone	See notes/source	*Jobs per model zone and sector in each modelling year*	Employment calculated based on land use change modelling resulting from accessibility changes (calculated by LUTI Consulting)
Proportion of employment by sector for each	See notes/source	*% of employment*	Shares of employment in each MSM zone were

[34] See Appendix E-F Land Use and Transport Interaction Modelling
[35] Note the GC matrices are the demand weighted average by journey purpose and mode to obtain one GC matrix per scenario per modelling year.

Element	Values	Unit	Notes / Source
sector set out in the MBCM: • Agricultural, utilities, other • Business services • Govt, Defence, medical, education • Industrial • Retail trade • Wholesale trade			calculated based on employment by ANZSIC industry classification for Auckland from 2018 census, which was matched to the ANZSIC 2006 sectors in the MBCM
Agglomeration elasticities by sector	*See source*	*elasticity*	Aligned with MBCM[36]
10-year average GDP per worker growth (2021 onwards)	1.29	*%*	Statistics on labour productivity, International Labour organisation (ILO)[37]
3-year average GDP per worker growth (2018 - 2021)	1.87	*%*	International Labour organisation (ILO)[37]
Auckland GDP	92,599,133	*$000s (March 2018)*	Stats NZ regional GDP
Employees	830,064	*persons*	2018 Census
GDP per worker	112	*$000s*	Calculation

The first step in the calculation requires calculating the demand weighted GCs for work travel purposes and commuting across all modes, following the formula set out in the MBCM shown in Equation 4 below.

Equation 4: Demand weighted generalised costs for work travel and commuting.

$$AGCij\ S = \sum Di,j\ *,m,p\ GCi,j\ S,m,p\ m,p\ /\ \sum Di,j\ *,m,p\ m,p$$

where:

- *AGC is the average generalised cost.*
- *D is the demand.*
- *GC is the generalised cost.*
- *S is the Do Minimum or option.*
- *m is the mode p is purpose.*
- *i is origin.*
- *j is destination.*

The next step involves estimating effective density in each scenario (Do Minimum and Project Option) following the methodology set out in the MBCM. This is based on demand

[36] Shares of employment in each MSM zone
[37] Retrieved from online open data source: 'Our World in Data'.

weighted GCs by journey purpose for both car and PT and employment in each scenario based on Equation 5.

Equation 5: Effective density estimation

$EDi\ S = \sum Ej\ S\ \ / AGCij\ S\ j$

where:

- ED is effective density.
- E is employment

An agglomeration elasticity is then applied to the change in effective density (ratio of effective density in Project Option to effective density in Do Minimum) to derive the productivity uplift. A weighted average elasticity is calculated in each zone based on the share of employment (Equation 6).

Equation 6: weighted average agglomeration elasticity by AFC MSM zone

$\varepsilon i = \sum (\varepsilon i\ S \times Ei\ S\ S\ ) / \sum Ei\ S\ S$

where:

- ε is agglomeration elasticity
- E is employment

The calculations are undertaken at MSM zone level following this formula:

$\delta PRi = (EDi\ OPT\ /\ EDi\ DM)\ \varepsilon i - 1$

where:

- δPR is relative increase in productivity.
- OPT is option.
- DM is Do Minimum.
- ε is agglomeration elasticity.
- i is zone.

Once the productivity uplift by zone is obtained, this is multiplied by the total GDP in each zone to obtain the agglomeration benefit. The total agglomeration benefit is the sum of the agglomeration benefit in each zone.

Once the productivity uplift by zone is obtained, this is multiplied by the total GDP in each zone to obtain the agglomeration benefit. The total agglomeration benefit is the sum of the agglomeration benefit in each zone.

2.2.5.b Imperfect competition

Imperfect competition benefits are the impact of transport infrastructure-induced increases in output in sectors with price cost margins.

Methodology

The methodology for estimating impacts on imperfect competition is to apply 10.7% of the business user benefits, as specified in section 3.12 of the MBCM guidance. The formula specified in the guidance is shown in Equation 7.

Equation 7: imperfect competition uplift to business user benefits calculation

$$Imperfect\ competition\ impact = \tau \times Business\ user\ benefits^{f}$$

where:

- $Business\ user\ benefits^{f}$ are total conventional user benefits accruing to those using ALR for business purpose from travel time and vehicle operating cost savings in forecast year f.
- τ is the imperfect competition uplift factor, specified as having a value of 10.7% in the MBCM.

Table 17: Inputs used to estimate imperfect competition benefits

Element	Unit	Notes / Source
Imperfect competition uplift to business user benefits	*10.7%*	MBCM

2.2.5.c Increased labour supply

These benefits account for the additional tax take that occurs when improved transport infrastructure increases the labour supply.

Methodology

Commuting cost savings are calculated directly by AFC based on the methodology specified in Section 3.11 of MBCM, noting that the MSM model does not recognise whether the origin or destination represents the place of employment for trips. To compensate for, AFC has assumed that the AM trip represents the trip to work, and the PM trip represents the return home from work.

A summary of the approach to calculating commuting cost savings is listed in Equation 8.

Equation 8: Commuting cost savings calculations

$$G_{i,j,}^{Opt} = \sum m(g_{i,j,}^{Opt} + g_{j,i,}^{Opt}) * (T_{i,j,}^{Opt} + T_{i,j,}^{DM}) / \sum m(T_{i,j,}^{Opt} + T_{i,j,}^{DM})$$

$$G_{i,j,}^{DM} = \sum (g_{i,j,}^{DM} + g_{j,i,}^{DM}) * (T_{i,j,}^{Opt} + T_{i,j,}^{DM}) / \sum (T_{i,j,}^{Opt} + T_{i,j,}^{DM})$$

where:

- $G_{i,j,}^{Opt}$ is average generalised cost across mode m, commuting purpose in option
- $g_{i,j,}^{Opt}$ is AM generalised cost for mode m, commuting purpose in option (this assumes AM commuting trips are going to work)
- $g_{j,i,}^{Opt}$ is transposed PM generalised cost for mode m, commuting purpose in option (This assumes PM transposed commuting trips are coming home)
- $T_{i,j,}^{Opt}$ is the AM commuting trips + PM transposed commuting trips for mode m in option
- $G_{i,j,}^{DM}$ is average generalised cost across mode m, commuting purpose in Do Minimum
- $g_{i,j,}DM$ is AM generalised cost for mode m, commuting purpose in Do Minimum (this assumes AM commuting trips are going to work)
- $g_{j,i,}^{DM}$ is transposed PM generalised cost for mode m, commuting purpose in Do Minimum (This assumes PM transposed commuting trips are coming home)
- $T_{i,j,}^{DM}$ is the AM commuting trips + PM transposed commuting trips for mode m in Do Minimum
- Mode m are car and PT

$$dG_i^{f} = \sum W_{i,j,}^{Opt,f}(G_{i,j,}^{Opt,c,f} - G_{i,j,}^{DM,c,f})$$

contd…

where:

- dG_i is the daily commuting cost savings for workers living in zone i in person-minutes
- $W_{i,j,}^{Opt}$ is the number of workers commuting from zone i to zone j in option. Assumed from 24hr commuting (car person + pt)/2
- $G_{i,j,}^{Opt}$ is the average generalised cost across commuting purpose in option between origin zone i and destination zone j
- $G_{i,j,}^{DM}$ is the average generalised cost across commuting purpose in Do Minimum between origin zone i and destination zone j

After commuting cost savings are calculated, standard MBCM processes are followed to calculate the net labour supply impact based on the parameters listed in Table 18 below.

Table 18: Inputs used for estimating labour supply impacts

Element	Value	Unit	Notes / Source
Tax parameter to convert gross earnings to net earnings	32	%	Kernohan and Rognlien (2011)[38]
Elasticity of labour participation with respect to wages	0.40	factor	Kernohan and Rognlien (2011)[38]
Tax take from additional labour supply	26	%	Kernohan and Rognlien (2011) [38]
Productivity of marginal labour market entrants relative to the average	81	%	Kernohan and Rognlien (2011) [38]

2.2.5.d Movement to more productive jobs (M2MPJ)

This is a new benefit considered in the CBC compared to the IBC, which measures the additional tax take when transport infrastructure induces workers to move to more productive jobs. As a result, this benefit reflects additional productivity benefits to society as workers change their location of work to take up a more productive job.

Section 3.9 of the MBCM guidance recommends that a full calculation of M2MPJ is performed, however, it does not specify the guidelines for calculating this impact. As such, this methodology used is based on UK guidance on wider economic benefits[39].

Methodology

The M2MPJ benefits will be calculated in compliance with Section 3.3 of UK Department for Transport's Transport Analysis Guidance (TAG) Unit 2.3 which recommends that "the valuation of the move to more/less productive jobs resulting from a scheme can be calculated in terms of GDP impacts from equation below. The associated welfare change, which is additional to user benefits, is equivalent to the benefits to the exchequer. These are the tax revenues resulting from changes in productivity and can be estimated as 26% of the resultant change in GDP".

[38] Source as recommended in IBC Peer Review
[39] UK Department for Transport (2018), TAG Unit 2.3 – Employment effects

Equation 9: Move to more productive jobs calculation.

$GDPA,f = GDPW\ B,f \sum (Ei\ A,f - Ei\ B,f)\ PIi$

$WI2f = \tau 1 * GDPA,f$

where:

- GDPA,f is the movement to more/less productive jobs impact of the alternative case (A) compared with the base (B), to be calculated. This will vary depending on the forecast year f.
- GDPW B,f is the national average GDP per worker in the base case B. This will vary depending on the forecast year f
- Ei is the total employment for each area i in the base (Do Minimum) B and alternative (project option) A case.
- PIi is the zonal productivity differential per worker in each area i. This is calculated by using median income per job in each travel zone.
- WI2f is the welfare associated with the move to more/less productive jobs
- $\tau 1$ is the tax take on the move to more/less productive jobs, currently estimated to be equal to 30%

The following will used as inputs to calculate M2MPJ:

- Do minimum employment from AFC MSM model.
- Project option employment from LUTI by travel zone.
- Median income per job by travel zone, calculated using 2018 Census data.
- GDP per worker estimates.

Limitations

This methodology relies on the estimation of median income per job by travel zone. No official productivity differentials are provided by the MBCM[40].

2.3 Project costs

Aligned with the overarching approach to economic assessment (see section 1.3).

2.3.1 Transport elements costs

Transport costs refer to the costs associated with the development and operations of the transport scheme, including consideration of changes to the wider transport network.

2.3.1.a Capital costs

The capital cost estimates, and construction timelines are for each of the project options, these inputs and the methodology for cost estimation is outlined in detail in the Cost Estimators Report[41]. These costs also include the associated property acquisition and management costs. In compliance with the MBCM guidance, P50 costs are selected to be modelled in the economic appraisal. No real terms construction increases have been considered in the economic appraisal.

[40] Income data is used as recommended in the Waka Kotahi (2020), Transformative Transport projects (Dynamic WEBS and land use benefits and costs)

[41] See Appendix E-D Shortlist Options Design Summary (including Cost Estimate Report)

2.3.1.b Operating, maintenance and renewal costs

The operating, maintenance and renewals cost estimates associated with the transport elements of the scheme and timelines are provided for each of the project options and the methodology for cost estimation is outlined in detail in the Cost Estimators Report[41].

2.3.1.c ALR revenues

PT revenue is provided in the transport modelling outputs from AFC. In line with Section 6.2 of the MBCM guidance, the public transport fare revenues are treated both as a disbenefit and negative cost in the calculation of BCR_g (Government Benefit Cost Ratio), which is a separate BCR in addition to the standard BCR_n (National Benefit Cost Ratio).

The revenue derived from the MSM model is in 2016 prices and is therefore uplifted to the economic model price year using the CPI rates for New Zealand[42].

2.3.2 Urban elements costs

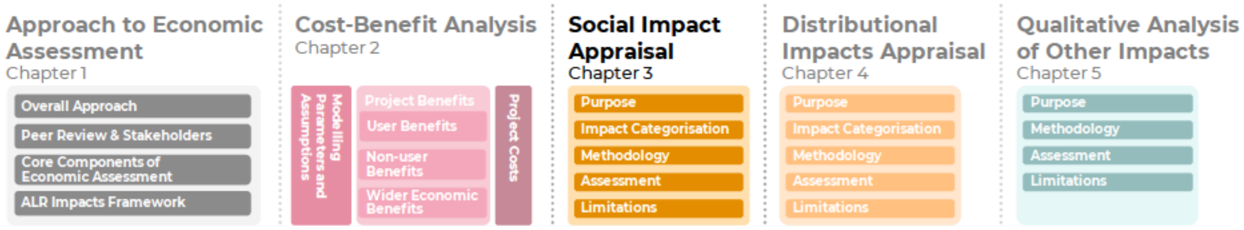
The type of interventions considered as part of the urban elements of the CBC, and their associated costs, are summarised in Phase 3 of the Optioneering Report, Appendix E-B. Recognising the higher level of analysis (minimum-IBC level of detail) contributing to the urban element project costs, an escalation factor has been applied to demonstrate P50 and P95 costs, summarised in Table 19 below.

Table 19: Urban cost escalation factors

Element	Value	Unit	Notes / Source
Base to P50 escalation factor	1.66	factor	Supplementary Green Book Guidance: Optimism Bias, Her Majesty's Treasury, United Kingdom (April 2013)
Base to P95 escalation factor	2.0	factor	Assumption based on industry standard sensitivity test for high cost

[42] StatsNZ, Consumer Price Index (Q2 2016 to Q2 2022)

3. Social impact appraisal (SIA)



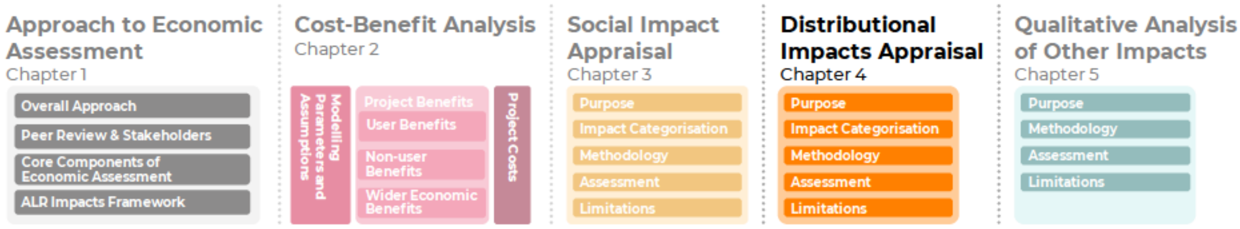
3.1 Purpose and Approach

ALR is expected to have social impacts for all individuals living and working along the CC2M Corridor, and across Tāmaki Makaurau Auckland's wider metropolitan area. The Social Impact Appraisal (SIA) looks at the human experience of a transport system, focusing on residents, and assessing social factors that are not already considered in traditional transport appraisals.

In the absence of specific guidance for the appraisal of social impacts of light rail interventions in Aotearoa New Zealand, the identification of likely social impacts of the Project is completed in accordance with the requirements set out in the *Transport Outcomes Framework* and based on specific guidance published by the NSW Government and the UK Department for Transport. Waka Kotahi guidance for the social assessment of highway interventions is also considered.

Please refer to Appendix E-H for details of the SIA methodology.

4. Distributional impact appraisal (DIA)



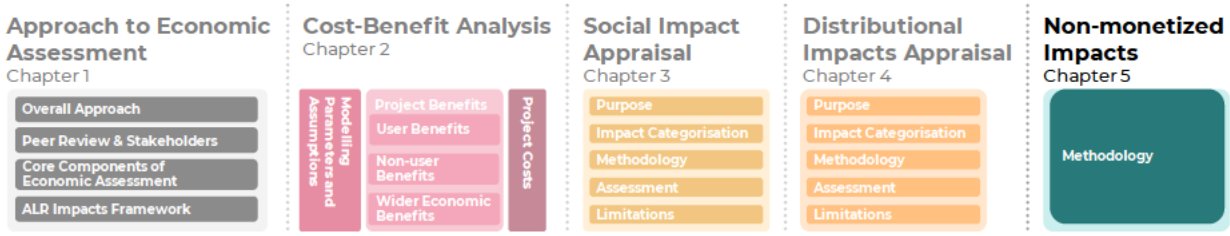
4.1 Purpose and Approach

The purpose of the Distributional Impact Appraisal (DIA) is to evaluate the distribution of ALR impacts (benefits and costs) among communities of concern compared to the rest of the population, and to suggest mitigation actions that will increase the equitable outcomes of this transformative project.

The approach to the appraisal of distributional impacts of ALR is based on the UK Department for Transport (DfT) TAG unity A4.2 Distribution Impact Appraisal. Further context and analysis are derived from a recent report commissioned by Waka Kotahi to investigate methods for identifying and evaluating the distributional impacts of transport interventions.

The details of the DIA methodology are presented in Appendix E-H.

5. Qualitative Analysis of Other Impacts



This section lays out the methodology for assessing impacts that are not monetised, either because there are no established methods or where quantitative measurement or monetisation alone is not appropriate. The non-monetised impacts have been assessed using inputs from the design and cost development analysis of ALR and the Intermediate Comparator as well as relevant light rail case studies. Consideration of impact on Mana Whenua and Māori in terms of social procurement and protection of environment has also been considered in the assessment.

The following non-monetised benefits have been assessed in the economic case:

- **Disruption from construction:** The costs/impacts which may occur due to the construction and implementation of ALR are assessed based on inputs from the design and cost development analysis of ALR.
- **Jobs during construction and operation:** The jobs associated with construction and operation of ALR are estimated using using inputs from the design and cost development analysis of ALR and the Intermediate Comparator.
- **Tourism** – It is anticipated that tourism activities are likely to increase due to better connectivity and accessibility because of ALR. It is to be noted that section 3.13 of MBCM does provide guidance on monetising the economic benefits of increased tourism. However, estimating the number of tourists is very challenging at this stage and therefore this impact is assessed only qualitatively using international case studies.
- **Foreign/inward investment** – The provision of good transport infrastructure and positive changes to accessibility, including improvements to the supply chain may encourage international investors to invest in the region. This impact is assessed only qualitatively using international case studies.
- **Additional capacity benefits/future proofing** – Benefits are anticipated with making provisions to accommodate future capacity (e.g., extra platform length). This is qualitatively assessed based on inputs from the network assessment report.
- **Resilience**: The resilience provided by ALR to external events is assessed using inputs from the design and cost development analysis of ALR and the Intermediate Comparator
- **Wider environmental impacts:** ALR is expected to generate and prevent wider environmental impacts on the natural environment, built environment, landscape and visuals, among other elements. A comprehensive identification and assessment of anticipated environmental impacts is presented in the Assessment of Effects on the Environment (AEE) report.

Appendix A IBC Peer Review Recommendations

Table 20 Recommendations from IBC peer review by John Williamson

Recommendation	ALR Approach
Appraisal period – To test if a longer appraisal period would cover >90% of benefits.	• Appraisal period has been adjusted to count 60 years from scheme opening, rather than from date of assessment. • This effectively extends the appraisal period by 10 years. • An additional benefit capturing residual asset value has been included to ensure the remaining useful life of infrastructure beyond the appraisal period is captured.
Ramp up should not be applied to core benefits as it could lead to a design with inadequate future capacity.	• Original recommendation from John Williamson was based on an assumption that the transport demand modelling already had a ramp up period applied. This is not the case. • The appraisal has adopted a demand ramp up of 50%, 75%, and 100% for all outputs derived from the transport modelling results. • Additional benefits, including WEBs and benefits associated with land value uplift have a separate ramp up period applied that is specific to those calculations. These assumptions are detailed where relevant.
The approach of capping benefits at the point where maximum capacity for each mode is reached is appropriate.	• The capping of benefits in line with the relevant system capacity of each proposed option capacity has been undertaken. • Additional land use change associated with urban investments has also been developed based on the capacity of the ALR system capacity. This has informed the overall quantum of benefits derived for each option.
Keep rule of half point as it is by treating all PT users that switch to ALR as existing users, so they get the full benefit.	• The application of the rule of half has been applied in the same way as the approach adopted in the IBC.
Include resource cost of fare revenue	• In line with Section 6.2 of the MBCM guidance, the public transport fare revenues are treated both as a disbenefit and negative cost in the calculation of BCRg (Government Benefit Cost Ratio), which is a separate BCR in addition to the standard BCRn (National Benefit Cost Ratio).
Application of a more appropriate carbon values.	• MBCM has been updated to align with Treasury CBAx tool guidance. The central scenario will be used for the core economic appraisal and a sensitivity test will be undertaken incorporating a higher carbon value.

Recommendation	ALR Approach
Estimate the avoided infrastructure costs (difference between two growth scenarios) for utilities other than transport and include in future BCR. Seek confirmation from Waka Kotahi as to the intention (scope) of this provision.	• Assessment of infrastructure cost savings has been calculated as part of the economic appraisal.
Consider combine testing of sensitivity tests to understand the effect of a number of factors occurring together.	• Sensitivity and scenario testing will incorporate adjustment to demand modelling inputs as well as a combination of sensitivity to measure the impact of uncertainty.
Include a demand led land-use scenario in the next phase of land use modelling and analysis.	• The LUTI modelling that has been prepared has been based on the outputs of the MSM transport demand model. • Urban uplift scenarios have been prepared in addition to this work. These scenarios will be informed by both supply and demand side factors.
The demand analysis will need to be accompanied by a corresponding assessment of the amount of development capacity needed to be realised in order to meet demand by location and how much more development capacity will need to be enabled, at which locations and at what point in time, to allow this to happen.	• Both supply and demand side analysis inform the assessment of land use change. This includes a combination of LUTI modelling and development capacity and feasibility assessments undertaken as part of the urban and urban commercial workstreams. • Further sections of the CBC will provide recommendations to ensure that the proposed development uplift can be realised.