

10 May 2022

To Dave Brash, Independent Chair, Let's Get Wellington Moving
From Blake Lepper, General Manager - Infrastructure Delivery, Te Waihanganga
Subject Carbon impacts of *Let's Get Wellington Moving*

Purpose of this review

The Chair of the LGWM Board, Dave Brash, requested that Te Waihanganga review the Economics Technical Report and the Carbon Technical Report (that inform the LGWM Preferred Programme Option Report).

While we have sought to provide as much support as possible in the timeframes, this does not constitute a full review of the LGWM economic analysis and carbon analysis. Instead to make the best use of the time available, and in line with the request, Te Waihanganga has focused on the two following elements:

- the likely magnitude of carbon reductions from LGWM at a high level, and
- the likely relative differences in carbon reductions between Option 1/2 and 41.

Our review is set within the context of *Rautaki Hanganga o Aotearoa, the New Zealand Infrastructure Strategy 2022 – 2052*, which sets out the country's infrastructure challenges and how to address them. The Strategy sets core principles for infrastructure decision-making and funding that underpin our view of how decision-makers should plan and invest in infrastructure.

Our review also considers the *Let's Get Wellington Moving* investment objectives, which set carbon emissions and mode shift as the single highest weighted objective (40%). Given that the core objective of the programme is carbon reductions, our expectation is that the programme should also contribute to achieving national carbon reduction targets.

Key findings

1. Option 4 is the best option from both a climate and economic perspective, and the only option that is likely to be compatible with our international commitments on carbon emissions.
2. The level of carbon emissions reductions is highly dependent on land use intensification. Enabling intensification is critical for the programme to succeed in cutting emissions.
3. Congestion charging has not been included in the carbon assessment or economic analysis. Congestion charging is a critical tool for improving access and mobility (while reducing carbon emissions) and should be considered an indispensable part of the programme.
4. The total magnitude of carbon savings is subject to uncertainty due to insufficient analysis in four areas: the level of intensification, construction times, the embodied emissions from construction, and the speed of electric vehicle uptake. However, evidence suggests that further work in these areas is likely to favour Option 4 (over Option 1/2).
5. More work is needed at the detailed business case stage to provide certainty around intensification, carbon outcomes, and delivery planning.

¹ While there would be differences between Options 1 and 2, they have been treated as equivalent in this letter because the high-level work completed to date does not show substantial differences between these options.

Transport investment and Rautaki Hanganga o Aotearoa

Rautaki Hanganga o Aotearoa, the New Zealand Infrastructure Strategy 2022 – 2052, sets out the country's infrastructure challenges and how to address them.

The Strategy outlines ten core principles for infrastructure decision-making:

1. Infrastructure problems and opportunities are quantified as part of long-term planning.
2. Delivery agencies identify infrastructure needs in response to quantified infrastructure problems.
3. Delivery agencies invest in feasibility studies to scope potential options.
4. Where an infrastructure need is identified, steps are taken to ensure potential options can be delivered affordably.
5. A detailed analysis of a potential project is undertaken through a business case.
6. Delivery agencies assess alternative funding sources for each potential project.
7. Meaningful stakeholder engagement is undertaken at appropriate points throughout project development and delivery.
8. All information supporting infrastructure decisions is publicly released.
9. Staged and post-completion project reviews are undertaken and publicly released.
10. Where a project is funded as part of a broader programme, the corresponding decision-making processes are robust and transparent and prioritise value for money.

With respect to carbon emissions, the strategy recommends that:

- investment programmes must be compatible with our international commitments on carbon emissions
- business cases include a full consideration of non-built solutions and decarbonising existing infrastructure.
- business cases include assessments of whole-of-life carbon emissions, including embodied, enabled, and operational emissions.
- cost benefit analyses use a cost of carbon compatible with international commitments on carbon emissions within all cost benefit analyses, outlined in the Treasury CBAX tool.

The strategy identifies congestion pricing as a key tool for improving access and mobility in New Zealand cities, while contributing to reducing carbon emissions. It recommends progressing planning for congestion pricing schemes for Wellington.

These principles and recommendations underpin our view of how decision-makers should plan for and invest in infrastructure and are the foundation of our advice to *Let's Get Wellington Moving* (LGWM).

1. Option 4 is the best performing option

The analysis that has been provided to us shows that:

- Options 1/2 begin to achieve net carbon emission reductions in 2055, while Option 4 begins to achieve net carbon emissions reductions a decade earlier, in 2045.
- In terms of carbon reductions, Option 4 outperforms Option 1/2 at all points in time and across all land use sensitivity tests.
- Option 4 has a higher benefit cost ratio under most scenarios.

Consideration of low-cost options before higher cost options is a fundamental infrastructure decision-making principle that is outlined in the New Zealand Infrastructure Strategy, as well as core guidance documents such as the Monetised Costs and Benefits Manual. The incremental cost of higher cost alternatives and options is only justified when it is outweighed by the incremental benefits gained. From an economic standpoint, the incremental cost of the higher cost option has not been justified.

From a carbon emissions perspective, Option 1 and 2 result in a net emission increase by 2050, showing that investment in one of these options would be fundamentally counter-productive to achieving our national carbon reduction targets. Option 4, in contrast, results in a modest net emissions reduction by 2050.

Te Waihangā is disappointed that none of the options presented result in substantial emissions reductions, in line with our 2050 targets. In addition, all the options presented have very high costs relative to the scale of emissions reductions, leading to a very high cost per tonne of carbon abated. Ideally, options would be developed that provide more cost-efficient means of reducing emissions.

Considering this, Te Waihangā is of the view that the DBC phase should continue to develop a full range of options to improve on Option 4 including greater consideration of complementary measures including congestion charging, travel demand management, and reallocating existing road space to walking and cycling is likely the optimal outcome from a carbon reduction perspective. The DBC phase should explore opportunities for cost and embedded carbon reduction and contain sufficient analysis to confirm that the final recommended option remains the best value investment option for New Zealand.

While the LGWM carbon analysis clearly indicates that Option 4 has higher emissions reductions, the LGWM economic analysis indicates that Option 1 and 2 have higher monetised benefits from emissions reductions. Our understanding is that this discrepancy between the two documents is because embodied emissions have not been monetised and included in the economic analysis and BCR calculation but have been included in the carbon analysis. The whole-of-life carbon emissions, including embodied, enabled, and operational emissions, should be monetised in all business cases.

2. Land use intensification is essential

The analysis provided indicates that the level of carbon emissions reductions is highly dependent on the level of land use intensification that is achieved because the carbon analysis clearly demonstrates that land use change is the significant contributor to reduced carbon emissions, rather than the transport improvements in isolation. In fact, the emissions reduction benefit of the programme without land use change appears to be relatively marginal.

Given the importance of land use intensification to both carbon and economic outcomes, it is surprising that the business case provides very little certainty on the level and timing of urban intensification associated with each option.

Transport investments alone will be insufficient to achieve land use intensification and will need to be complemented with an enabling planning and consenting framework and other necessary infrastructure investments. These are not optional or complementary measures - the programme's success depends on them. The IBC has not adequately identified the necessary conditions for the assumed levels of intensification, and this should be a key focus at the DBC stage.

3. Congestion charging is a key tool

A core component of sound infrastructure decision-making is the consideration of non-infrastructure solutions and low-cost options before making the decision to invest in new infrastructure. The investment options outlined by LGWM are very high cost, relative to the amount of emissions reductions achieved. Te Waihanga is concerned that lower cost options have not been adequately considered.

The scale of carbon reductions estimated from LGWM indicates that further interventions will be required for the region to meet its carbon reduction targets in the transport sector. Further interventions should focus on non-built solutions and making better use of existing infrastructure, through measures such as pricing, travel demand management, and reallocation of existing road space to walking and cycling.

Congestion pricing and road tolling have been proven to increase access and mobility by reducing excessive traffic congestion. By raising the cost of using a private vehicle relative to public transport and active modes, congestion pricing can be an effective way to incentivise residents towards low-carbon transport alternatives. One recent study found that some congestion pricing schemes have had a significant impact, accounting for emission reductions of more than 10%².

We consider congestion pricing key to success for LGWM and recommend you include it as a core component of the programme. Other opportunities for non-built solutions and making better use of existing infrastructure should also be explored.

4. Uncertainty remains, but likely favours Option 4

The approach used to assess carbon emissions for the IBC is highly focused on transport modelling. While transport modelling is clearly important as it underpins estimates of enabled emissions, four other inputs are also key to estimating carbon emissions impacts: the level of intensification, construction times, embodied emissions from construction, and the speed of electric vehicle uptake. Unfortunately, the work completed in these areas is quite preliminary and sensitivity testing has not been used to examine how changes in the assumptions used in these areas may influence benefit levels and the relative benefits between options.

We have investigated the assumptions used for each of these variables and the extent to which uncertainty may change the relative benefits between Options 1/2 and 4.

Construction times

Delivery timelines are critical for achieving meaningful carbon reductions. Because New Zealand has adopted ambitious reductions targets that will require deep reductions in transport emissions by

²https://www.researchgate.net/publication/314866006_The_potential_of_road_pricing_schemes_to_reduce_carbon_emissions

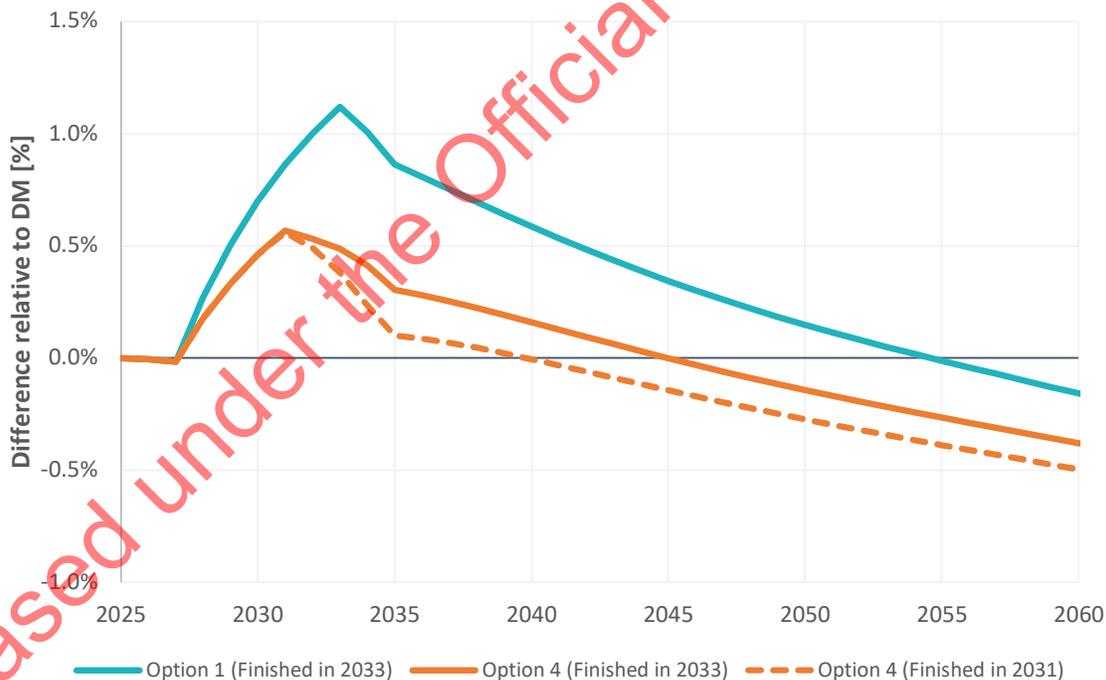
2030 and 2050, lengthy delivery times will compromise the ability of projects to contribute to achieving our national carbon reduction targets. Public sector investment programmes should be compatible with our international commitments on carbon emissions and result in net emissions reductions by 2050.

In the carbon analysis that has been provided, it is assumed that Options 1/2 and 4 have the same benefits realisation period. For both options, construction is completed in 2033 and benefits are not fully realised until 2036. However, these assumptions are at odds with other LGWM documentation, which indicates a 10-15-year construction period for Options 1/2 and an 8-12-year construction period for Option 4.

Figure 1 outlines that there are substantial carbon emissions benefits associated with shorter delivery timeframes. If Option 4 had a benefits realisation period two years faster than Option 1, this would result in the project reaching net carbon reductions by 2040 – 5 years faster than is currently assumed.

Given that Option 4 is lower cost, has fewer interdependencies, and may be easier to consent, it seems reasonable to conclude that it could be faster to deliver than Option 1 or 2. If this is the case, carbon benefits are likely to be much higher for Option 4, relative to Option 1/2.

Figure 1: Cumulative carbon emissions, relative to do minimum³



Embodied emissions from construction

Business cases should include assessments of whole-of-life carbon emissions, including embodied emissions from construction. Embodied emissions can be very significant for major infrastructure

³ WTSM Preferred Option & VEPM6.2 Emission Rates, Core Land use, Light Vehicles Only, Wellington Region

projects, particularly where tunnelling and major earthworks are required. As embodied emissions are likely high for LGWM and could materially impact the relative attractiveness of options, the IBC should have included as robust an analysis of embodied carbon as was feasible, given the information available.

Unfortunately, the approach used to estimate and present the embodied emissions is very preliminary. The analysis estimates that embodied emissions from Options 1 and 2 are more than two times higher than Option 4 (120,000 tonnes vs. 55,000 tonnes). The large difference in embodied emissions between options is a main reason why Option 4 is the best performing option for carbon outcomes. Because of the importance of these estimates, it is critical to test the accuracy of embodied emissions assumptions. In the absence of information from detailed design, sensitivity testing and benchmarking against other projects provide an alternative mechanism for providing confidence in embodied carbon assumptions.

The Waka Kotahi Carbon Baselines Project (2022)⁴ provides emissions baselines for the construction, operation, and maintenance of land-based transport infrastructure. The study provides an embodied emissions estimate of 10,000 tCO₂e /lane km for tunnel only projects, with a range of -20% to +10% across the three observed projects. The study does not include an estimate of carbon emissions for light rail projects. Olugbenga et al (2019)⁵ investigate embodied emissions from rail infrastructure using 57 case studies from Asia, Europe, and North America. The study provides an embodied emissions estimate of 422 tCO₂e/lane km for at-grade light rail projects, with an observed standard error of 296 tCO₂e/track km across the seven observed projects. Furthermore, the study finds that on average, tunnelling has 27 times more embodied emissions per kilometre than at-grade rail construction.

The results of these two studies are broadly consistent with the LGWM embodied carbon estimates. We can conclude that while the exact magnitude of embodied carbon emissions from LGWM is uncertain, we can be relatively confident in the large relative difference in emissions between Option 1/2 and Option 4. If anything, the results from Olugbenga et al (2019) favour Option 4 and suggest that the relatively lower emissions of Option 4 may be understated.

The speed of electric vehicle uptake

The level of emission reductions that can be expected from the programme is highly dependent on the speed of electric vehicle uptake. As electric vehicles become an increasing share of the vehicle fleet, the carbon savings from enabled emissions decreases. Slower electric vehicle uptake will favour Option 1 because it would increase the size of enabled emissions reductions over the long term, while faster electric vehicle uptake would favour Option 4.

The LGWM carbon assessment has used VEPM 6.2 national level fleet projections for its analysis, which projected that 61% of distance travelled would be by electric vehicles by 2050. The latest release, VEPM 6.3, has increased estimates of electric vehicle uptake, to 68% electric by 2050.

Furthermore, the analysis has used national level fleet projections, which are likely inappropriate given the high level of electric vehicle uptake in the Wellington region. In March 2022, electric vehicle uptake in Wellington was 2.3 times higher than the national average (0.8% of vehicles vs. 1.8% of vehicles).

⁴ <https://www.nzta.govt.nz/assets/resources/carbon-emissions-baselines-for-infrastructure-projects/carbon-emission-baseline-recommendations-for-new-zealand-infrastructure-projects.pdf>

⁵ <https://iopscience.iop.org/article/10.1088/1748-9326/ab442f/pdf>

When combining the two factors above, our view is that more accurate assumptions of electric vehicle uptake are very likely to favour Option 4, as the relative carbon reduction benefits of Option 1/2 would be reduced.

5. More work is needed at the detailed business case stage

It is vital that the DBC contains sufficient analysis to confirm that the final recommended option is the best value investment option for New Zealand. To this end the DBC should provide updated the counterfactual analysis that reaffirms any IBC decisions. Investment decisions should only be made on the basis of a robust LCA, and clearly articulated marginal abatement costs that allow this investment to be compared with other possible investments on a 'like for like' basis.

Te Waihanga recommends that further work is undertaken in these areas at the detailed business case stage including on:

The level of intensification

- The DBC should identify that the programme's success is dependent on intensification and what would need to be done to deliver this so the Cabinet, the WCC and GWRC can consider supporting interventions alongside LGWM.
- Further analysis of the magnitude and timing of future urban intensification is required to provide a better understanding of the level of certainty which can be ascribed to a given growth scenario and consideration as to how certainty may be increased.
- Where the benefits of urban intensification are being captured, it would also be appropriate to recognise any costs incurred in the delivery of these benefits. This suggests the need to consider the appropriate scope of the DBC.

Embodied emissions from construction

- The assessment at the DBC stage would benefit from more detailed understanding of level of embodied emissions.
- The DBC should include a robust consideration of the opportunities that are available to reduce the carbon emissions from construction.

Delivery planning

- A more detailed assessment of the construction times for the options is required.
- Detailed design decisions should prioritise choices that enable faster delivery timelines, as faster delivery will accelerate emissions reductions.

Electric vehicle uptake

- More locally appropriate data on the projected speed of electric vehicle uptake is required to improve confidence regarding the timing and scale of emissions reductions.

Further measures to reduce carbon emissions

- Given that further interventions will be required for the region to meet its carbon reduction targets in the transport sector, opportunities for non-built solutions and making better use of existing infrastructure should be explored at the DBC phase.
- This should include demand management through pricing as well as travel demand management and reallocation of existing road space to walking and cycling.