WELLINGTON ROAD JUNCTION IMPROVEMENTS

Options Appraisal - Carbon

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Table of contents

1.	Introduction	4
1.2.	Terminology	4
2.	Methodology	5
2.2.	Embodied Carbon Emissions	5
2.3.	End-User Carbon Emissions	5
2.4.	Assumptions & Limitations	5
3.	Assessment Results	7
4.	Conclusions and Next Steps	9
4.2.	Next Steps	10

Figures

Figure 3.1 - Carbon emissions for each option over 60-year appraisal period 7

Figure 3.2 - Construction emissions by DMRB Series for Option H. Provided as indicative carbon hotspots as this was the highest emitting option for construction emissions. Note that RRS and Drainage were not assessed at this stage. 8

Tables

Table 4-1 : Whole Life Carbon Emissions Summary Appraisal Table 9

1. Introduction

1.1.1. This report presents the methodology, assumptions and results associated with the whole life carbon option appraisal for the Wellington Road Junction Improvements at Design Manual for Roads and Bridges (DMRB) Stage 2. Although there is currently no statutory requirement for assessing whole life carbon at this project phase, this strategic estimate has been undertaken in support of the DMRB Stage 2 optioneering process and in light of recent international, national, and local carbon reduction requirements and activities.

1.1.2. The aim of this assessment has been to estimate whole life carbon emissions through the application of appropriate techniques (proportionate to the level of information available) to enable a consistent, semi-quantitative comparison across options. Carbon estimates presented within this document have been based on limited, high-level design data for comparative purposes and should therefore be regarded as indicative only. Increasingly detailed carbon assessments can be undertaken over the course of project development as more design information becomes available. Recommendations for carbon reduction are beyond the scope of this report.

1.1.3. A Carbon Management Plan (CMP) has been prepared for the scheme outlining how the project will embed PAS 2080:2023 ‘Carbon Management in Buildings and Infrastructure’ through the project’s lifetime from options appraisal to as built.

1.2. Terminology

1.2.1. The term tonnes of carbon dioxide equivalent (tCO_2e) refers to the equivalent global warming potential of carbon dioxide (CO_2) and is used to represent all greenhouse gas (GHG) emissions in a common unit. Embodied carbon (or capital carbon) refers to the GHG emissions associated with the creation of an asset and applies to the construction phase of a project. It is comparable to capital cost. Operational carbon refers to the GHG emissions associated with the operation and maintenance of an asset and is comparable to operational cost. Whole life carbon (WLC) is the combination of both embodied and operational carbon and is comparable to whole life cost. Finally, user carbon refers to the GHG emissions associated with the use of an asset (e.g. vehicle emissions) and can only be influenced, not directly controlled.

1.2.2. For the purposes of this report, the term carbon has been used as shorthand to refer to all relevant GHG emissions.

2. Methodology

2.1.1. The following section outlines the methodology applied to estimate carbon emissions associated with eleven route options for the Wellington Road Junction Improvements, known as Options A through K respectively.

2.1.2. As the impact of carbon emissions is global in nature (relative to localised environmental impacts), and due to the format of available quantity data, options have been assessed on an end-to-end basis only. Further information on the approach to assessing emissions is provided below.

2.2. Embodied Carbon Emissions

2.2.1. Embodied carbon has been calculated by multiplying material quantities from the Cost Estimates provided by the design team with appropriate emission factors taken from CESSM4 (Carbon and Price Book, 2013). Although high-level, this has been done to ensure consistency between the cost estimation for each option and the carbon associated with each.

2.2.2. The per unit carbon values (i.e. 'factors'), in $kgCO_2e$, associated with relevant design elements were calculated. These factors were applied to total quantities on a per unit basis to obtain approximate embodied carbon values. CESSM4 provides carbon values that include the emissions associated with materials and plant emissions from construction. At this stage, emissions associated with the transportation of materials to site have been excluded.

2.3. End-User Carbon Emissions

2.3.1. End-user carbon emissions results have been based on Transport User Benefit Appraisal (TUBA) outputs.

2.3.2. Values represent the total modelled change in vehicle emissions between 'Do Minimum' and 'Do Something' scenarios over a 60-year appraisal period, based on predicted diesel, petrol, and electric vehicle consumption.

2.4. Assumptions & Limitations

2.4.1. In the absence of detailed design information at DMRB Stage 2, several assumptions were necessary to develop representative carbon factors for key scheme quantities. For example, the absence of drainage data for each option and assumptions concerning emissions for each toucan crossing.

2.4.2. Emissions associated with certain life cycle modules (e.g. maintenance and decommissioning) have been excluded from this assessment due to data limitations and inherent uncertainty at this stage of the project. The scope of assessment will be expanded in future phases as more design information becomes available for the preferred option.

2.4.3. TUBA data assumes all carbon emissions will be constant after 2050. The values for the following years (for the 60-year appraisal period) are an estimate, which are likely to be higher than projections for future traffic composition.

2.4.4. Finally, due to the high-level nature of this assessment, as well as the assumptions and limitations stated above, all carbon values are intended to be used on a relative/comparative basis and should be considered ***indicative only***.

3. Assessment Results

3.1.1. This section provides the results of the DMRB Stage 2 Carbon Option Appraisal, which has focused on approximate whole life carbon emissions.

3.1.2. Figure 3.1 presents the comparative whole life (i.e. embodied and operational) carbon emission estimates for all options, as per the methodology described in Section 2. Changes in user emissions are shown as positive values, as they are expected to increase in all scenarios over the 60-year assessment period.

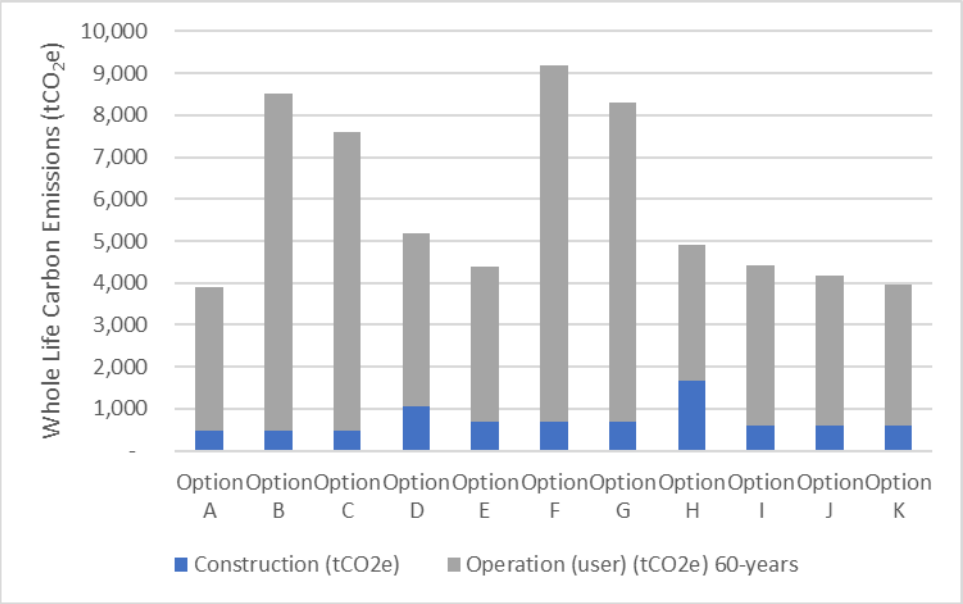

Figure 3.1 - Carbon emissions for each option over 60-year appraisal period

3.1.3. This shows that emissions during construction are generally much lower than user emissions during the 60-year appraisal period, however as described above there are some elements (e.g. drainage, operation and decommissioning) that were not assessed due to high-level nature of the data.

3.1.4. Aligned to PAS 2080:2023, opportunities to mitigate carbon emissions should be taken at each project stage. There will certainly be opportunities through design to mitigate carbon reductions of the preferred route. To give an indication of where likely carbon hotspots through construction are likely to occur, Figure 3.2 provides an indicative breakdown of carbon emissions by DMRB series for Option H as this was the option that scored most highly with regards to carbon emissions during construction.

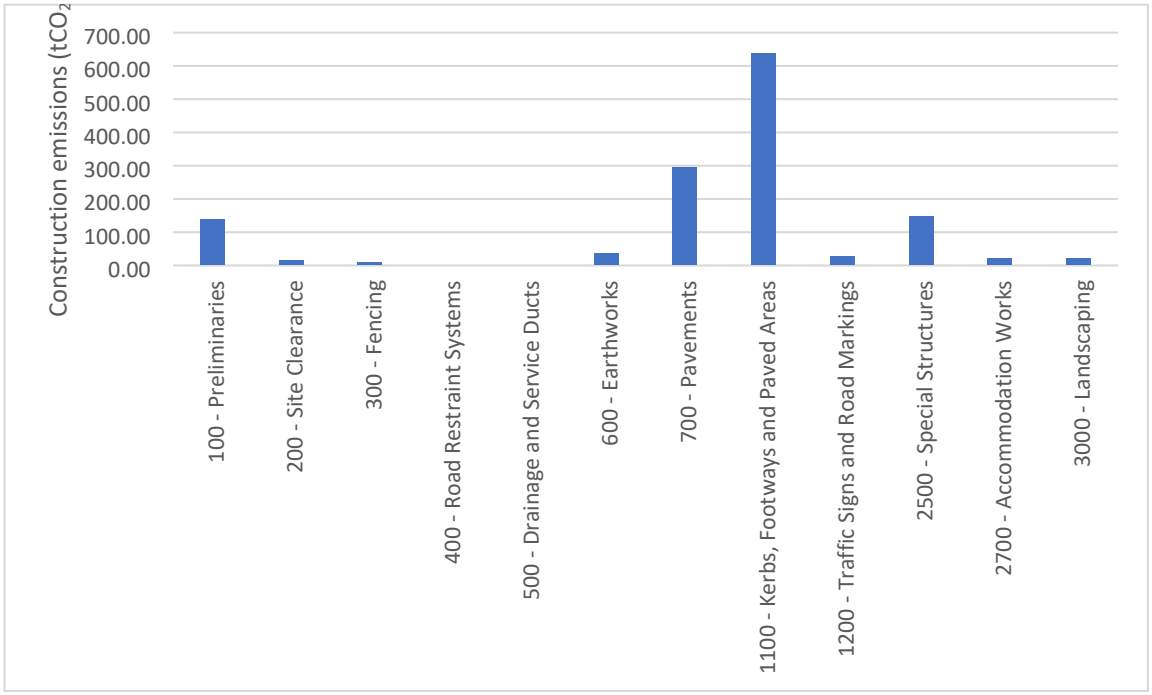

Figure 3.2 - Construction emissions by DMRB Series for Option H. Provided as indicative carbon hotspots as this was the highest emitting option for construction emissions. Note that RRS and Drainage were not assessed at this stage.

3.1.5. Although Option H may not be taken forward as the preferred option, the carbon hotspots identified provide a good starting point for carbon mitigation workshops that take place in DMRB Stage 3.

4. Conclusions and Next Steps

4.1.1. Table 4.1 provides a summary of the assessment results for all route options. A rank between 1 and 11 has been provided, based on the total estimated carbon emissions of each alignment option. An impact result used to populate the scoring matrix has also been given – note that all options are ranked as negative given the increase in emissions that would be expected both through construction and operation.

4.1.2. Route Option A is shown to have the lowest whole life carbon emissions, as well as the lowest carbon emissions through construction.

4.1.3. Route Options B and F have the highest whole life carbon emissions, despite lower emissions at the construction stage than Options D and H. The higher whole life carbon emission totals for Options B and F are the result of significantly higher emissions during operation compared to the other modelled route options.

Table 4-1 : Whole Life Carbon Emissions Summary Appraisal Table

Route Option	Option A	Option B	Option C	Option D
Construction (tCO_2e)	476	476	476	1,069
Operation (User) (tCO_2e)	3,426	8,044	7,119	4,125
Total emissions (tCO_2e)	3,902	8,520	7,595	5,194
Ranking	1	10	8	7
Impact Scoring	-1	-3	-3	-2

Route Option	Option E	Option F	Option G	Option H
Construction (tCO_2e)	691	686	686	1,678
Operation (User) (tCO_2e)	3,701	8,514	7,609	3,225
Total emissions (tCO_2e)	4,392	9,200	8,295	4,903
Ranking	4	11	9	6
Impact Scoring	-2	-3	-3	-2

Route Option	Option I	Option J	Option K
Construction (tCO_2e)	596	597	597
Operation (User) (tCO_2e)	3,835	3,564	3,370
Total emissions (tCO_2e)	4,431	4,161	3,967
Ranking	5	3	2
Impact Scoring	-2	-1	-1

4.2. Next Steps

4.2.1. Moving forward, in line with PAS 2080:2023, once a preferred option has been selected, and in line with the Carbon Management Plan produced for the scheme, carbon workshops will be held with the design team to ensure that opportunities to minimise emissions during DMRB Stage 3 are assessed and implemented. This will include developing a detailed bottom-up carbon assessment of the preferred option that can be used to identify hotspots and ensure continued carbon mitigation actions are taken through future project stages and into construction.