Milford Opportunities Project

STAGE 3 - CARBON ASSESSMENT

17 APRIL 2024

STAGE 3 - CARBON ASSESSMENT

Milford Opportunities Project

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REV	DATE	DETAILS
001	23/02/2024	First draft for client review
002	18/03/2024	Final Report
003	4/04/2024	Final Revised Report
004	17/04/2024	Updated Final Revised Report

	NAME	DATE	SIGNATURE
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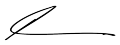
Approved by:	Andrew Bruce	20/03/2024	

EXECUTIVE SUMMARY

The Milford Opportunities Project is a long-term vision and strategy for the user experience in Milford Sound Piopiotahi that is being developed to address key existing and future challenges. As part of this Vision, the Milford Opportunities Project is tasked with looking at greenhouse gas (GHG) emissions across the project lifecycle and finding efficient and innovative ways to reduce emissions for the project.

The report documents the carbon assessment mahi completed to date and should be used as a baseline to inform further assessments and design work in subsequent stages of the project. The carbon assessment provides an estimation of emissions for proposed project infrastructure within the categories of Transport, Structures, 3 Waters and Facilities. The main tool used to complete the initial carbon assessment for the Transport, Facilities and 3 Waters assets is the Project Emissions Estimation Tool (PEET) version 4.0, developed by Waka Kotahi, Auckland Transport (AT) and KiwiRail.

The report outlines infrastructure lifecycle assessment (LCA) stages from best practice frameworks such as *PAS2080 2023: Carbon Management in Infrastructure*. The assessment aligns with the LCA stages where information was available, and provides an estimation of carbon emissions by material type, and at each LCA stage as summarised below:

Infrastructure Type	LCA Module Stage			
	A: Construction before use	B: Operation and Maintenance	C: End-of-life	D: Beyond building lifecycle
Transport	1,545 tCO2e	2691 tCO2e Across 50-year lifecycle for parking and carriageway rehab and refurb	2,763 tCO2e for parking and carriageway rehab and refurb	-
3 Waters	84 tCO2e Requires further quantification	Requires further quantification	Requires further quantification	-
Facilities	4,419 tCO2e	711 tCO2e Across 50-year lifecycle for track maintenance	366 tCO2e for track maintenance	-

The carbon assessment for the **Structures** assets was completed using the building lifecycle assessment tools LCAquick, One Click LCA, and a WSP building assessment tool. A range of emissions were calculated for different design options detailed in the report. Results for Structures showed Modules A1-A3 (Material emissions), B1 (refrigerant leakage) and B6 (Operational Energy) were most carbon intensive.

The material hotspots identified in the carbon assessment include aggregate, asphalt and sealing chip, cut to waste, steel, concrete, fibercement, and construction fuel. These are

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found across the four infrastructure types and should be further assessed in subsequent assessments and included in design and optioneering.

Not all items within the cost estimate were quantified as an estimate of carbon emissions. The items not quantified will add to the emissions profile of the project, and there is potential that some of these items will have a material impact on the emissions profile. Examples of these include the proposed cable car, the wastewater treatment facilities and toilets, and the use of helicopters during construction in remote areas. Information on the details required are included within this report, and should be quantified in the next update of the carbon assessment.

This report does not cover enabled emissions, or certain transport assets such as the proposed Park and Ride, which are specified in the exclusions and appendices of this report.

The report identifies decarbonisation opportunities for each infrastructure type that should be explored in early design phases and included in optioneering.

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GLOSSARY

Key Terms	Definition
CO_2	Carbon dioxide
CO_2e	Carbon dioxide equivalent, is a measure of greenhouse gas emissions, expressing them in terms of CO_2 normalised by their global warming potential.
Emissions	Greenhouse gases emitted into the atmosphere.
Embodied emissions	The total GHG emissions and removals associated with materials and construction processes throughout the whole life cycle of an asset.
Enabled emissions	The total GHG emissions associated with the utilisation of infrastructure by third parties.
Greenhouse gases (GHGs)	Atmospheric gases that trap heat and contribute to climate change. The gases covered by the Climate Change Response Act 2002 are carbon dioxide (CO_2), methane (CH4), nitrous oxide (N2O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), and sulphur hexafluoride (SF6).
Life Cycle Carbon	The total sum of all asset-related GHG emissions and removals, both operational and embodied over the life cycle of an asset including its disposal
Mitigation	Mitigation is doing what we can to stop producing emissions and reduce the impacts of climate change.
Sustainability	Ensuring the wise use and management of all resources within a framework in which environmental, social, cultural, and economic wellbeing are integrated, balanced, and considered

1 PROJECT BACKGROUND

1.1 PROJECT VISION

The Milford Opportunities Project is a long-term vision and strategy for the user experience in Milford Sound Piopiotahi that is being developed to address key existing and future challenges. The vision considers local, regional and corridor development to change the way we visit and interact with Te Rua-o-Te-Moko/Fiordland while restoring and safeguarding the natural and cultural heritage for Ngāi Tahu and its visitors[1].

1.2 BACKGROUND

As part of this Vision, the Milford Opportunities Project is tasked with looking at greenhouse gas (GHG) emissions across the project lifecycle and finding efficient and innovative ways to reduce emissions for the project. This carbon assessment is one part of a larger goal and collective effort to reduce the impact we have on Milford Sound Piopiotahi so it can thrive for generations to come.

The project has been through a Masterplanning phase where concepts for the Opportunities Project were developed and presented. As the Transport and Infrastructure workstream moves into the first phase on Stage 3 of the project, the technical feasibility of the infrastructure proposed in the Masterplan is being considered and tested.

As part of Stage 3, a Sustainability Assessment was commissioned by the Milford Opportunities Project. WSP were appointed to undertake a carbon assessment of the embodied carbon of the proposed infrastructure as part of the Sustainability Assessment. A reverse scope was provided to the Milford Opportunities Project to outline the scope for the Carbon Assessment and was accepted on 9th January 2024. This scope is contained in Appendix A.

This assessment will enable the project to assess areas of high carbon emissions and identify potential opportunities to reduce these emissions across the project and its lifecycle. Opportunities identified will aim to align and reflect the project's vision of restoring and respecting the natural environment of Milford Sound Piopiotahi.

This report contains a summary of the approach which was undertaken to calculate the carbon assessment for the Milford Opportunities Project, and the results of this assessment. The specific boundaries of this assessment and the inclusions and exclusions of the assessment are covered in section 2.

Detailed calculations and emissions (tCO_2e) per category are shown in Section 3 and in Appendix G.

[1] Milford Opportunities Project Masterplan, 2021. 210503-MOP-Masterplan-FINAL.pdf (milfordopportunities.nz)

2 APPROACH TO ESTIMATING INFRASTRUCTURE CARBON

2.1 BOUNDARY OF ASSESSMENT

As per WSP's agreed scope, shown in Appendix A, the Carbon Assessment aids in understanding the implications of the development through a carbon lens. The assessment covers the embodied emissions associated with the infrastructure; the construction energy requirements to build it; the transportation emissions associated with the material delivery; and the maintenance and end of life emissions, in line with best practice.

The list of assets included in this carbon assessment was sourced from:

- *Request for Proposal, MOP Engineering Feasibility Assessment, Appendix A – Schedule 1. Stage 2 Cost Infrastructure Assessment Report, Appendix 2 Cost Estimates for Infrastructure Proposals*

These documents are contained in Appendices E and D.

The list of assets to be included in the carbon assessment was received by WSP from DOC on 24th January 2024. Reference details for each of these infrastructure assets were assessed to determine if there was sufficient information to quantify individual carbon emissions, and whether these were included in the Sustainability Scope, attached as Appendix A.

Following this, the cost estimate spreadsheet was provided to WSP for the carbon assessment on 1st February 2024, attached in Appendix H - Copy of 06 - Milford Opportuntity_Cost Estimates V5 20201130_no photos. This formed the boundary of the carbon assessment. This was copied into a working copy Carbon Assessment Workbook – Appendix B – Asset list and assumptions (tab 'Cost Estimate' and tab 'Reference Costing'). This Carbon Assessment Workbook is the copy used by WSP to quantify carbon emissions, as shown in tabs Methodology', 'Summaries', 'Structures', 'Facilities', '3 Waters', 'Transport', 'Maintenance', 'End-of-Life', using the supporting tab 'EFs' with emission factors sourced from PEET4.0 and used for the calculations.

A meeting was held with WSP cost estimation team to discuss any queries and assumptions developed by the carbon assessment team. No further information or updated cost estimate was provided after this meeting on 7th February 2024, and therefore the carbon assessment is based on the items provided in Appendix H, and quantified in Appendix B. Please note, this does not include all cost estimate items quantified, just those discussed for potential overlap. The items excluded from this assessment are identified in Section 2.3.2 of this report.

A workshop was held with MOP Project Manager to confirm the scope of the assessment and the list of assets included and excluded from the assessment. The session discussed the underlying assumptions developed for the assessment and was confirmed to be appropriate and comprehensive. The workshop presented the initial findings of the carbon assessment, identifying carbon hotspots and potential reduction opportunities.

A second workshop was held with WSP, DOC and Beca on 15th February 2024 to review the list of assets with potential overlap between the two independent carbon assessments, and to agree the boundaries of each assessment. The meeting reviewed Appendix B and the items listed in tab

'Cost Estimate'. Appendix D show the extrapolated items that were discussed as having potential overlap and requiring a resolution, which was reached in the meeting and recorded in Appendix D column J 'Resolved'. The scope of assessment for Beca covers the enabled emissions due to infrastructure use. This carbon assessment is completely focussed on embodied, lifecycle carbon in the built infrastructure so includes construction energy and embodied carbon from construction and maintenance. The proposed Park and Ride system related embodied emissions as part of the Transport System & Design Contract are also out of scope for this carbon assessment, as they are included in Beca's. Confirmation of the scope and boundary of the items discussed in the meeting is attached in Appendix D.

It is important to note that the carbon assessment is a snapshot of the emissions calculated for the asset information available at that point in time. This assessment does not consider additional infrastructure or design information established following the Stage 2 cost estimate – *version provided by MOP's Senior Project Manager for Infrastructure Engineering* (Appendix H).

This assessment is inclusive of proposed infrastructure at the nodes and hubs of the project and associated infrastructure at the time of receiving the Stage 2 cost estimate (Appendix H), and based on the content of the meetings held as noted above, and the information available at the time of assessment.

It is important to note that the original WSP Sustainability Scope for the carbon assessment, attached as Appendix A, did not include operational emissions (module B6), but did include embodied emissions associated with the construction and maintenance of the assets. Following the workshop discussion with Beca and MOP held on 15th February 2024, lifecycle modules B2-5 (maintenance emissions) and C (end-of-life emissions) were agreed to be added into WSP's carbon assessment to provide an emissions estimate that accounted for more of the lifecycle assessment stages. These estimates for maintenance and end-of-life were added in for Transport and Facilities assets components, for a 50-year design life. Estimates have also been provided for Structural assets. 3 Waters assets were not included in the assessment of maintenance and end-of-life due to the level of detail which was contained in the cost estimate for these assets at the time.

2.2 LIFECYCLE ASSESSMENT STAGES

The illustration below demonstrates the lifecycle stages for infrastructure construction. These modules are based on the British Standard: BS *EN 15978:2011 Sustainability of Construction Works. Assessment of environmental performance of buildings*. The stages are also referenced by PAS2080 2023: Carbon Management in Infrastructure and detailed further in Table 1. Presenting the lifecycle carbon assessment in these modules enables measurement and tracking emissions at each stage to understand where project emissions are present, and how they compare between stages to identify reduction opportunities at each stage of the project's lifecycle.

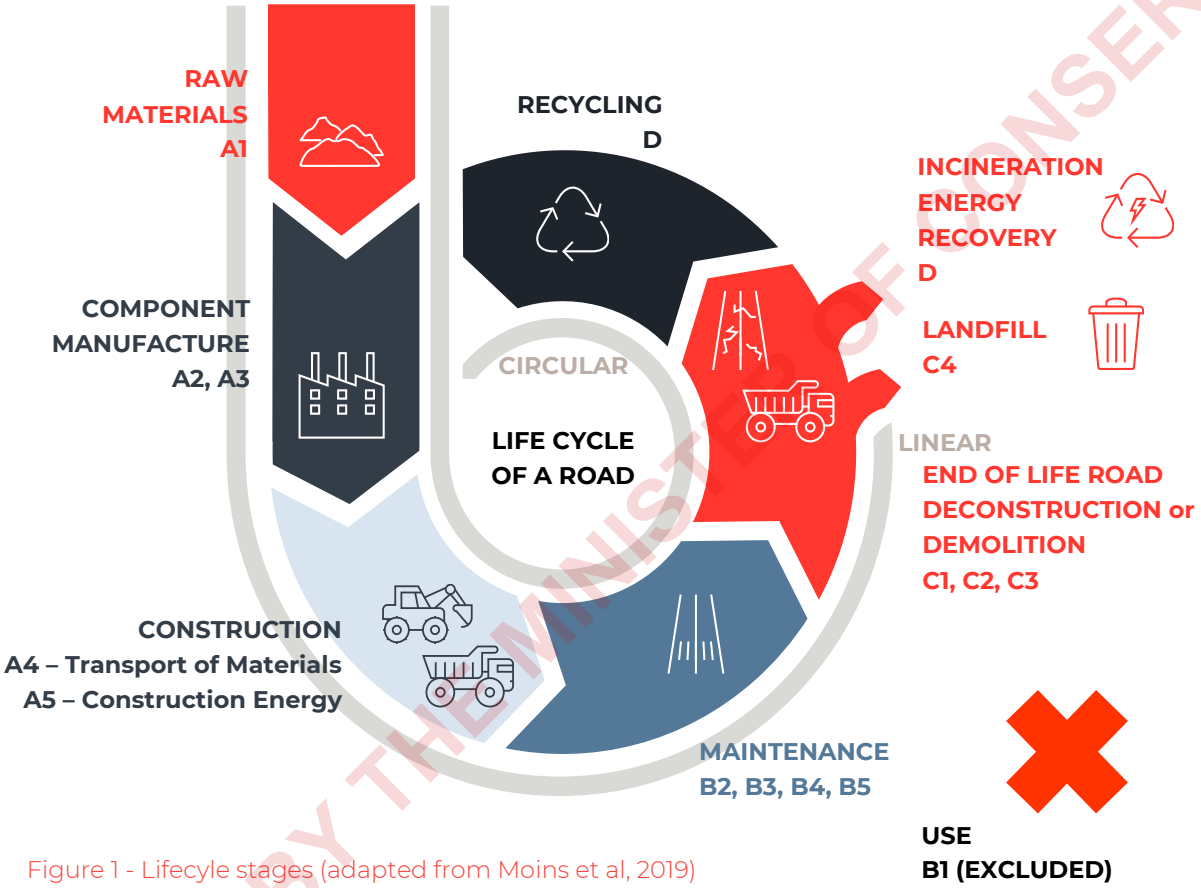

Figure 1 - Lifecyle stages (adapted from Moins et al, 2019)

Table 1 - LCA stages

LIFECYCLE STAGE MODULE	LIFECYCLE STAGE	DESCRIPTION
A1-A3	Before Use stage (Materials)	The emissions from raw material supply, transport and manufacture
A4	Before Use stage (Construction)	The emissions from transport of materials to the worksite
A5	Before Use stage (Construction)	The emissions from construction and installation process
B1	Use stage	Use of infrastructure
B2-B5	Use stage	The emissions from maintenance, repair, replacement, and refurbishment of the asset/infrastructure
B6	Use stage	The emissions from operational energy usage
B7	Use stage	Operational water
C1-C4	End-of-Life stage	The emissions from deconstruction, transport, and waste processing
D	Beyond Life – Resource recovery stage	The emissions from resource recovery and recycling processes

The assessment of emissions under each module is dependent on the scope of the emissions assessment and whether each stage is applicable, and if there is sufficient information to quantify each stage of emissions. The stages assessed and applicable to this report are identified in Table 2.

3 METHODOLOGY

The main tool used to complete the initial carbon assessment for the Transport, Facilities and 3 Waters assets, as categorised in the Carbon Assessment Workbook (Appendix B), is the Project Emissions Estimation Tool (PEET) version 4.0, developed by Waka Kotahi. The carbon assessment for the Structures assets was completed separately using the building lifecycle assessment tools LCAquick, One Click LCA, and a WSP building assessment tool.

The full methodology followed to develop the Carbon Assessment was as follows:

1 Stage 2 Cost Estimate data reviewed, as shown in the 'Cost Estimate' tab.

2 Items filtered into categories, aligned to the cost estimate asset types: Structures, Facilities, 3 Waters and Transport and copied these into individual sheets. Items and the listed unit and quantity copied into Carbon Assessment workbook (Appendix B).

3 Additional details were sourced from the Reference Costing sheet tab (Appendix B). Where it seemed applicable, material breakdowns and quantities were utilised to expand the cost estimate item quantification. These were cross-referenced with the WSP project manager and cost estimate team during a meeting held on Wednesday 7th February 2024.

4 Items were quantified based on the unit required in the PEET 4.0 tool for each specific material. Assumptions are documented where material unit conversions and estimated material specs have been used.

5 Where assumptions are made on the material types and quantities, these are documented in the Assumptions tab in each worksheet. The *MOP Walking & Cycling Feasibility Report*[2] was used to cross reference track dimensions and materials with the reference costing details.

6 The materials were quantified both in PEET and our workbook - emission factors used in PEET were carried over into our workbook. This facilitated the calculation of emissions broken down for each asset rather than only one single emissions estimate for the project.

7 Each emission stage is shown to represent the embodied, transport and construction emissions of the cost estimate item/material, shown in A1-A3, A4 and A5 assessment stages. The activities and materials applicable to each stage were quantified.

8 Material Element Emissions Subtotal (A1-A3) represents the embodied emissions of individual materials.

9 Construction Transport Materials to Site (A4) has been quantified using 8% total embodied emissions of A1-A3, which is best practice used in the PEET4.0 Tool based on research conducted by Waka Kotahi (AECOM, 2023). This is shown in Appendix B in the 'Methodology' tab.

[2] Southern Land Ltd 2023. Milford Opportunities Project: Walking & Cycling Experiences Report Prepared by Southern Land Ltd for Milford Opportunities Project

10 Construction Fuel Used on Site (A5) has been quantified using 21% total embodied emissions of A1-A3, which is best practice used in the PEET4.0 Tool based on research conducted by Waka Kotahi (AECOM, 2023). This is shown in Appendix B in the 'Methodology' tab.

As mentioned above, the Lifecycle Assessment (LCA) Modules aligns with best practice framework *PAS2080: Carbon Management in Infrastructure* to estimate emissions across the project's lifecycle. The module assessment for each project category is summarised below in Table 2.

Table 2 - LCA Modules assessed for each project category

LCA Module Assessment Table					
	Module	Transport	Facilities	3 Waters	Structures
A	**Construction** (before use stage)	Included	Included	Included	Included
B	**Operation** and **Maintenance** (use stage)	Estimated for parking and carriageway rehab and refurb **(B2-B5)**	Estimated for track maintenance **(B2-B5)**	Not included	Not included*
C	**End-of-life** stage	Estimated for parking and carriageway rehab and refurb	Estimated for track maintenance	Not included	Included
D	**Beyond building** lifecycle	Not included	Not included	Not included	Biogenic Included

*The only scenario that includes module B is the one storey building scenario. For further reasons behind excluding module B refer to "Limitations",4.2.3. Also, regarding B6 some rough estimates are given in section 4.2.5.

Items identified as 'Not included' were considered not feasible to estimate based on the level of project detail at this stage. Additional details about specific items excluded are shown below.

3.1 ASSUMPTIONS AND EXCLUSIONS

3.1.1 ASSUMPTIONS

The following assumptions have been made for a high-level estimate of the carbon emissions of the MOP infrastructure.

1. All items quantified have been sourced from the cost estimate data (Stage 2 cost estimate).
2. The high-level details found within the reference costing tab were applied to individual cost estimate line items where applicable.
3. Reclaimed Aggregate Pavement (RAP) and Supplementary Cementitious Materials (SCM) are not included. Not including these is considered Business as Usual for New Zealand.
4. Detailed assumptions for material quantification can be found within the carbon assessment workbook.
5. Material breakdowns and quantities were used from product specification assumptions where detail was not available within the cost estimate data.
6. All fuel activities quantified are assumed to be diesel.
7. All quantified 3 Waters pipes include trench aggregate allowance.

8. Transport of Materials to Site (A4), As a proportion of the total (A1-A5) construction emissions assumed to be 8%. Estimate of emissions associated with fuel and energy use by plant and machinery operating on site, based on research conducted by Waka Kotahi (AECOM, 2023)
9. Fuel and Energy Use on Site (A5), As a proportion of the total (A1-A5) construction emissions, assumed to be 21%. Estimate of emissions associated with fuel and energy use by plant and machinery operating on site, based on research conducted by Waka Kotahi (AECOM, 2023)
10. Operation and Maintenance were estimated for Transport and Facilities assets (parking areas, road and shoulder realignments) requiring rehab and reseal periodically over the asset's lifespan.
11. Regarding the vertical structures' material quantities, the amounts are calculated based on rules of thumb for building type and Gross Floor Area (GFA), and previous similar projects estimations and research. The calculations of quantities and assumptions are done by structural engineers and architects.
12. The structures' estimations depend heavily on assumptions and the calculations are done by different tools depending on the available information including LCAQuick, OneClick, WSP in-house tool.
13. Databases used for structures' calculations include Gabi, EPDs, and BRANZ data sheets.

3.1.2 EXCLUSIONS

The following items from the Stage 2 Cost Estimate have been excluded from the carbon assessment as they are considered out of WSP's scope as they are covered in the carbon assessment completed by Beca.

1. *Transport Buses - Capital Investment, Phase 1, 2 and 3*
2. *Transport Terminal – Buses – Base of Operations – Parking - Housing of shuttles and buses - includes allowance for charging hubs.*
3. *Transport Terminal – Buses – Base (Generator) Power for charging hubs - Backup generator.*
4. *Transport Terminal – Buses – Base (Generator) Power for charging hubs – Transformer.*
5. *Transport Terminal – Buses – Base of Operations – Building/structure for drivers and maintenance.*
6. *Park and Ride carpark Te Anau.*
7. *Shuttles and shuttle base.*

The following items from the Stage 2 Cost Estimate have been excluded from the carbon assessment as there was not enough detail available on the material breakdown and quantification of these items to develop assumptions and calculate the emissions in PEET4.0. The carbon assessment does not account for additions in scope added following the completion of this report. If material and quantity details are now available for these items, these should be quantified in the next stage of the carbon assessment.

8. *Establishment, Traffic Management, utility services & contingency of track services (referenced in Appendix B tab 'Reference Costing' column G allowance).*
9. *Supply and installation of 500kW Turbine and Generator at Milford Sound Piopiotahi*

10. *Allowance to realign existing power near the Hub – Piopiotahi Power Cabling*
11. *Cable Car at Piopiotahi*
12. *Piopiotahi Potable Water – Valves* – no emission factor available in the estimation tool and deemed insignificant (<5%) to the overall emissions.
13. *Piopiotahi Wastewater Treatment (upgrade to existing with Consent renewal in 2028).*
14. *Jetty facility that would align with the Visitor Hub. Developed based on demand at location* – only the boardwalks associated with this facility have been included.
15. *Super Track Head - Potable Water Services - Package water supply and treatment for servicing super track head, with intake from the Hollyford River.*
16. *Piopiotahi Potable Water Storage to increase the half day storage currently available.*
17. *Te Huakaue Knobs Flat/ Kiosk Creek Accommodation – Wastewater treatment system based on small catchment and disposal to ground, noting that there are poor conditions, and a vaulted system may be required.*
18. *Te Anau Wastewater Council Connection (Hub).*
19. *Te Anau Potable Water Council Connection (Hub).*
20. *Corridor – FNP threshold – Constructed entrance for the corridor experience.*

Additional exclusions within the Structures assessment are detailed in Section 4.4 in the Structures results section of the report. Some life cycle modules have not been included in the study because there is little to no available information. B1, B5, B6 and B7 are excluded from the LCA modelling in this feasibility & business case phase.

4 INFRASTRUCTURE CARBON ASSESSMENT RESULTS

The carbon assessment has been broken down into four different categories related to the proposed infrastructure types. These categories were reviewed during a meeting with the WSP Project Manager and MOP's Senior Project Manager for Infrastructure Engineering and agreed as an appropriate categorisation of the emissions assessment based on the cost estimate data breakdown.

- Transport
- Structures
- 3 Waters
- Facilities

Results are presented below for individual lifecycle stages across the project, as aligned to the summary presented in Table 2. The results are summarised by infrastructure category for the categories quantified at each stage. The Structural assessment was completed using a different methodology, and therefore these results are presented separately in Section 4.4 below.

4.1 CONSTRUCTION EMISSIONS (BEFORE USE STAGE) – LCA MODULE A

4.1.1 TRANSPORT EMISSIONS

The emissions for transport-related activities categorised by lifecycle stages and material breakdown are shown below. The items quantified for the transport emissions assessment include asphalt (asphaltic Concrete, hot mix asphalt, 5% virgin bitumen), aggregate, cut-to-waste (removed material from existing site), and sealing chip. The proposed large areas of pavement and carpark surfacing, and therefore large areas of asphalt, result in the highest material emissions for transport-related materials. Asphalt has a higher emission factor (the rate at which an activity releases greenhouse gases) than aggregate. The large volumes of aggregate estimated for the proposed transport-related works also result in a large proportion of this emissions profile from aggregate. Cut to waste indicates the cut and removal of material from site, which results in higher levels of fuel consumption and the replacement of this material. Activities that were indicated as 'sealed' result in additional emissions from sealing chip on top of the asphalt or aggregate layer. Decarbonisation opportunities that could reduce these emissions are discussed in Section 5.2.

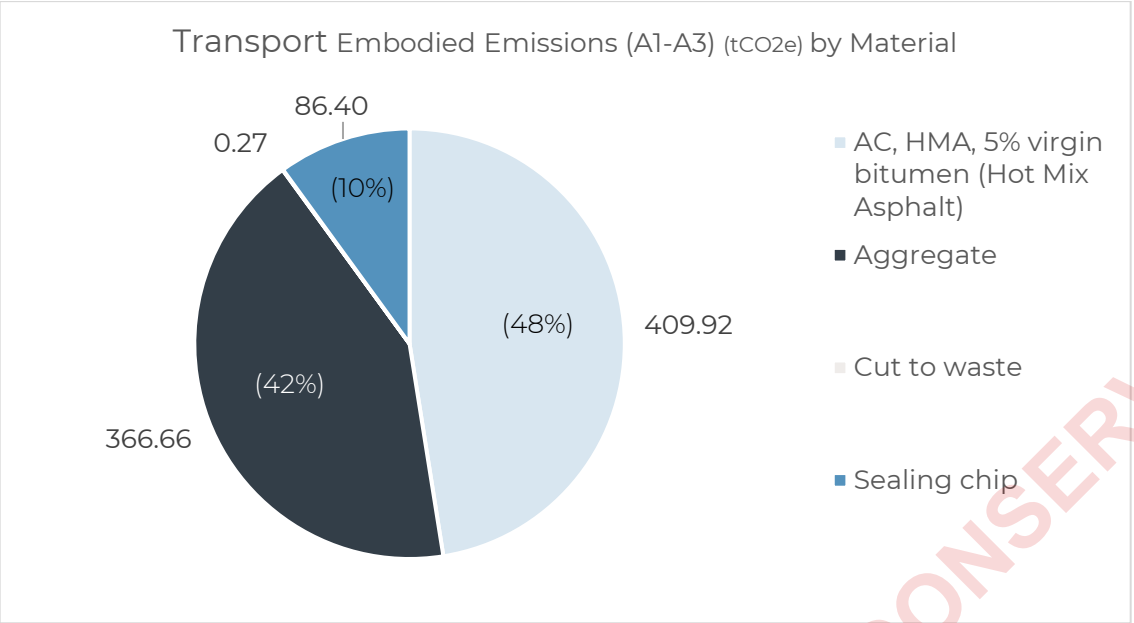

Figure 2 – Transport category emissions by material

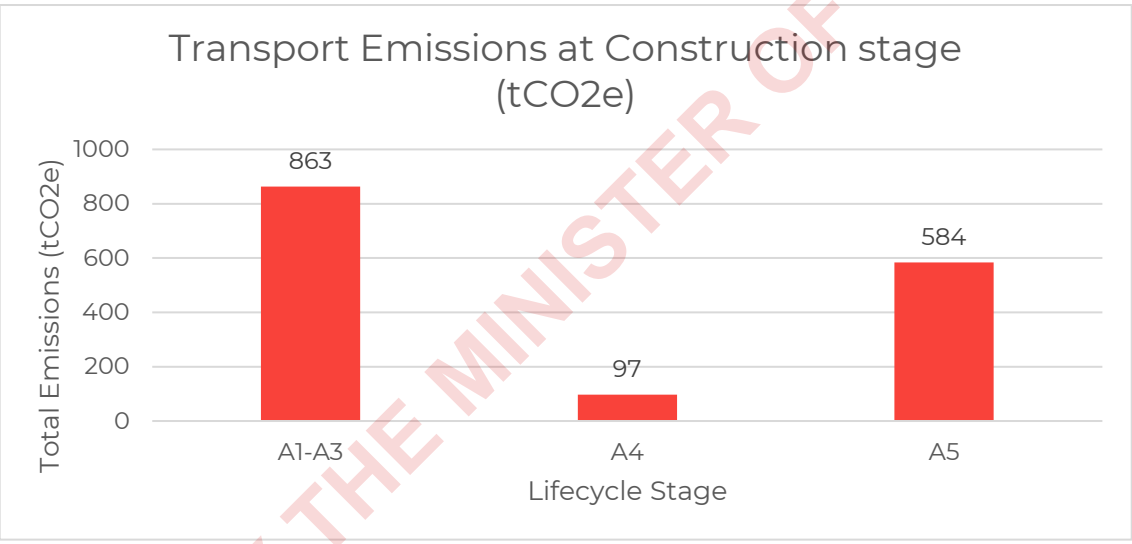

Figure 3 – Transport category emissions by LCA Stage (A1-A5)

At the construction (before use) stage, the highest emissions for the materials quantified come from the embodied emissions of the materials themselves (A1-A3). That is, the emissions associated with material extraction, manufacturing, and transport to site. The second-highest lifecycle stage is the fuel used on site for construction activities (A5).

4.1.2 FACILITIES EMISSIONS

The facilities assessed include walking tracks, boardwalks, viewing platforms, bridges, and pavilions. The estimate of carbon emissions includes the embodied emissions of the associated materials, and the earthworks required for each type of facility. The Walking & Cycling Feasibility

Report[3] was also referenced to ascertain track dimensions, to align with and add to the information within the Stage 2 Cost Estimate Reference. The Stage 2 Cost Estimate Reference information is shown in Appendix B tab 'Reference Costing'.

[3] Southern Land Ltd 2023. Milford Opportunities Project: Walking & Cycling Experiences Report Prepared by Southern Land Ltd for Milford Opportunities Project

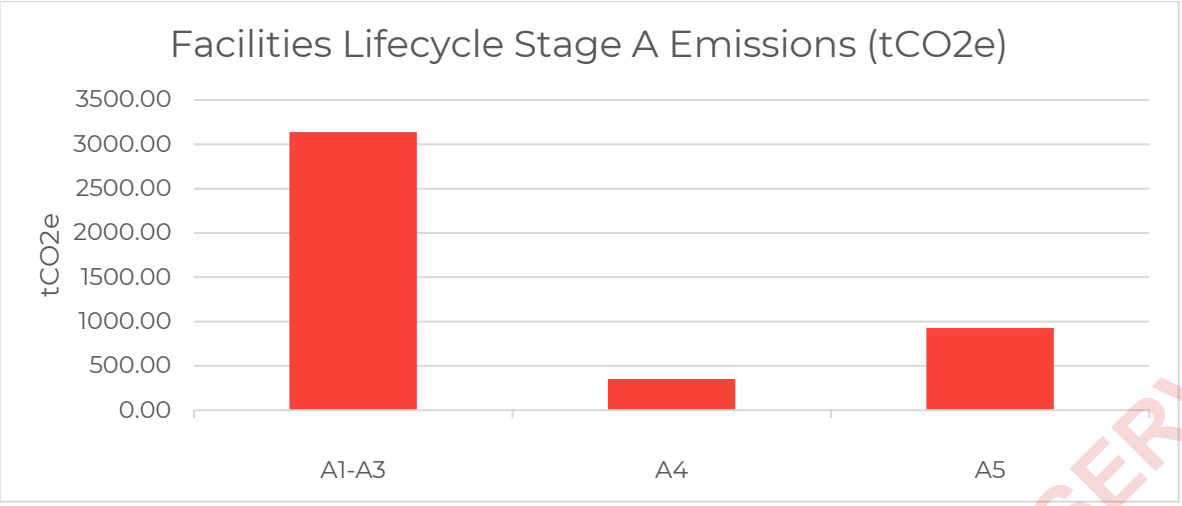

Figure 4 – Facilities category emissions by LCA Stage (A1-A5)

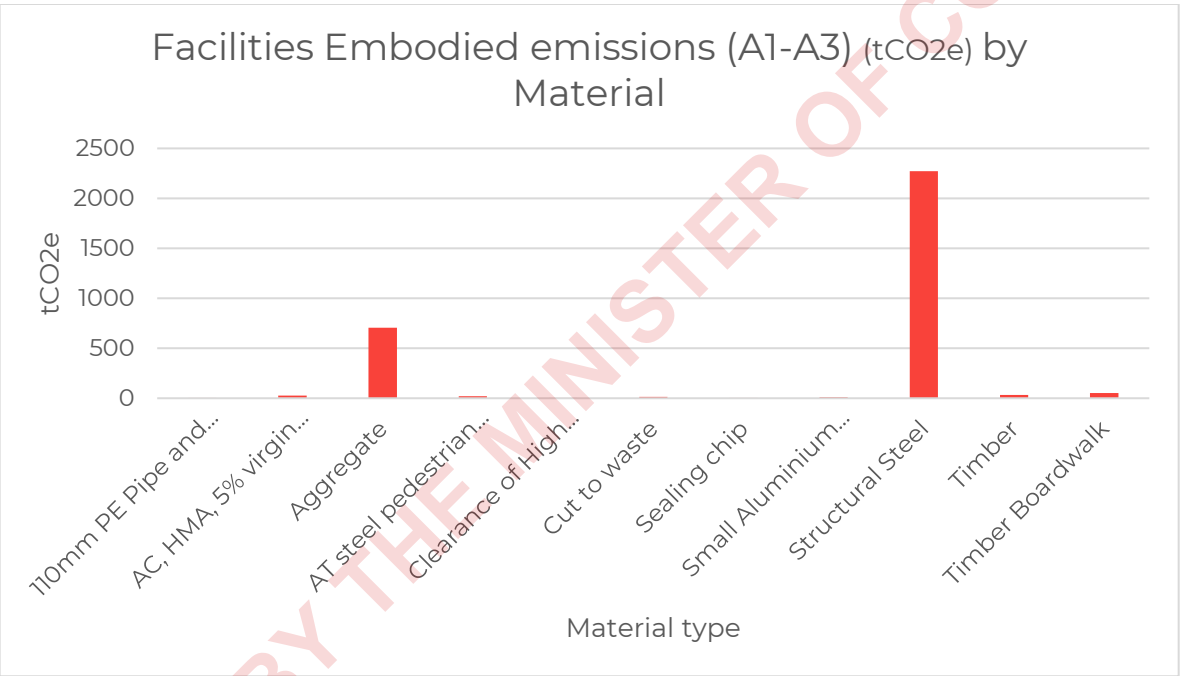

Figure 5 – Facilities category embodied emissions by material

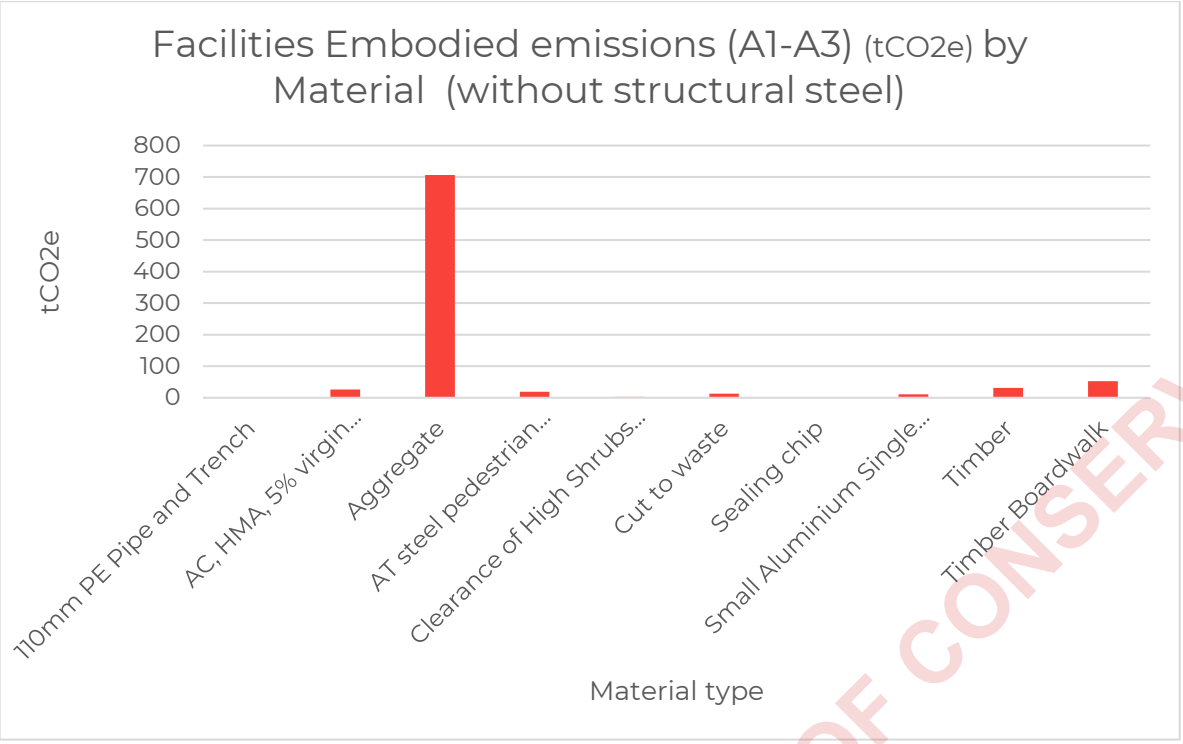

Figure 6 – Facilities category embodied emissions by material (without structural steel)

4.1.3 3 WATERS EMISSIONS

The emissions for 3 Waters-related activities categorised by lifecycle stages and material breakdown are shown in the below. The items quantified for the 3 Waters emissions assessment include cover pipelines, manholes and conveyance assets. The results show the highest emissions are from the embodied emissions of the materials themselves. In the PEET4.0 Tool, the emissions quantification of manholes is based on the following assumption: *Concrete manhole with standard 600mm diameter hole, 1.2m riser and flanged base with cast iron lid and reinforcing.*

As identified in the Exclusions section, the wastewater treatment components have not been quantified due to the lack of detail on the asset size, material composition and quantities. These emissions should be accounted for as they can form a significant proportion of the lifecycle carbon. When more information is available, this should be considered in the carbon assessment going forward.

The 3 Waters category items that were quantified in this assessment are shown in Appendix B, tab '3 Waters':

- Piopiotahi wastewater pipelines and manholes
- Knobs Flat experience hub potable water pipelines, wastewater pipelines and manholes
- Knobs Flat and Super Track Head toilet blocks (only the slab base estimated)
- Te Anau Visitor Hub wastewater pipelines and manholes, potable water pipelines

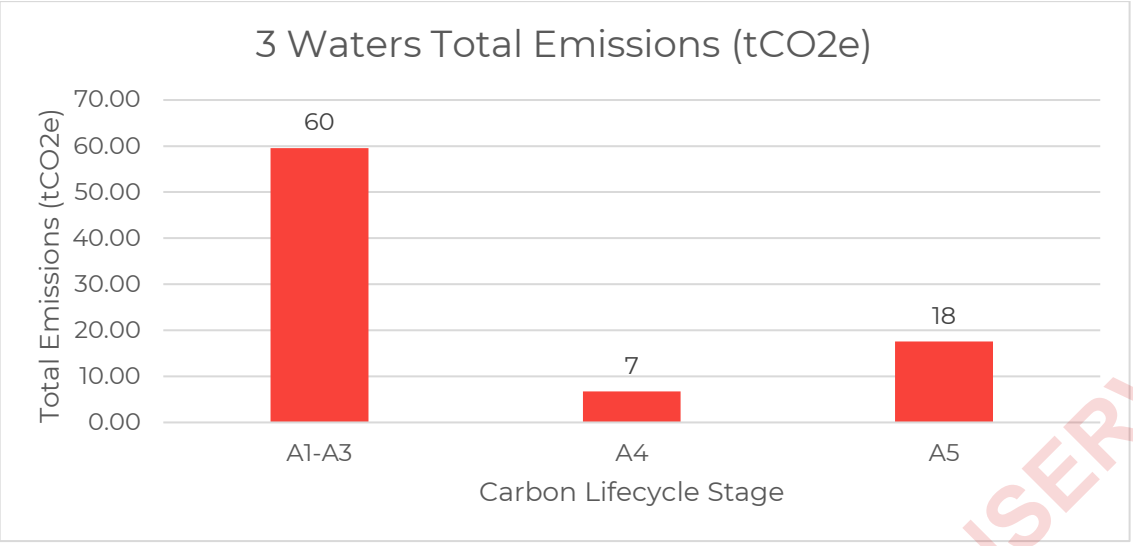

Figure 7 - 3 Waters category emissions by LCA Stage (A1-A5)

Based on the estimated items within the 3 Waters category, manholes have the highest emissions across the 3 Waters emissions profile. This should be expanded in the next stage of the carbon assessment to include a more comprehensive estimate of the project's proposed wastewater infrastructure emissions.

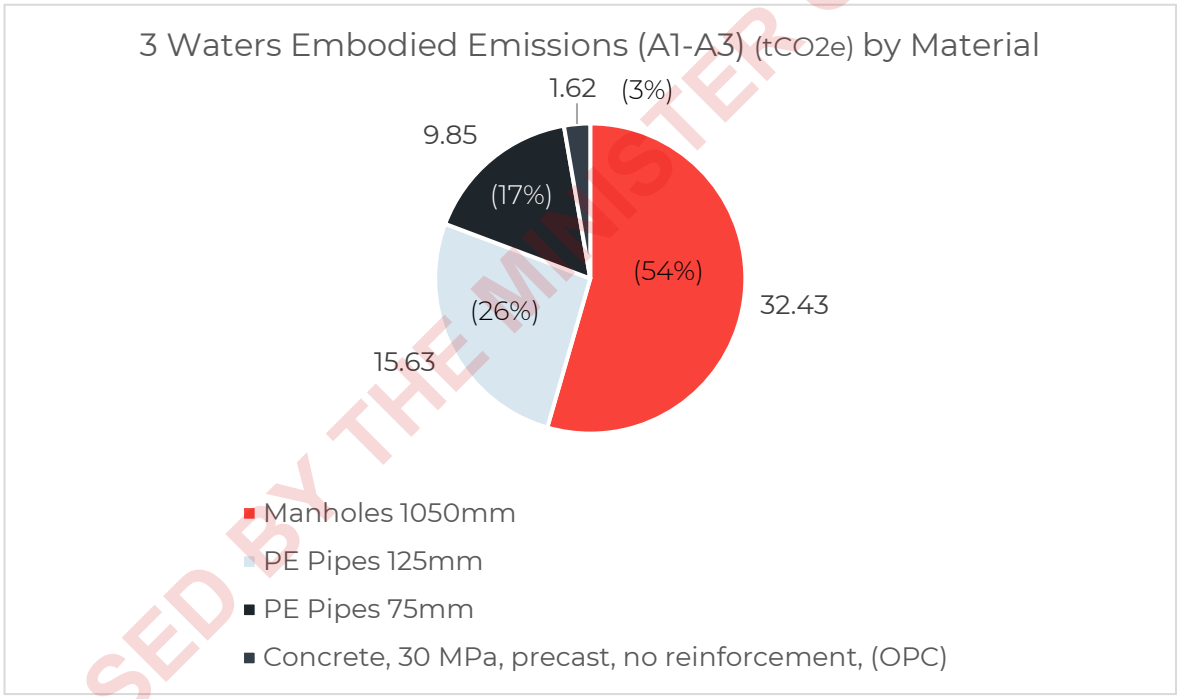

Figure 8 - 3 Waters category emissions by material

4.2 OPERATION AND MAINTENANCE STAGE – LCA MODULE B

The results of the quantified transport infrastructure and facilities emissions at the operation and maintenance stage show total emissions from resealing and rehabilitation activities for a 50-year asset lifecycle. Transport infrastructure-related activities had the highest maintenance emissions due to the estimated resealing and rehabilitation for large parking and pavement areas required across the lifecycle. This includes asphalt and sealing chip which have higher emission factors than aggregate. The transport infrastructure-related maintenance emissions are higher compared to facilities, where the majority of maintenance activities would be tracks upgrades on the running course aggregate layer, therefore less rehabilitation and resealing required.

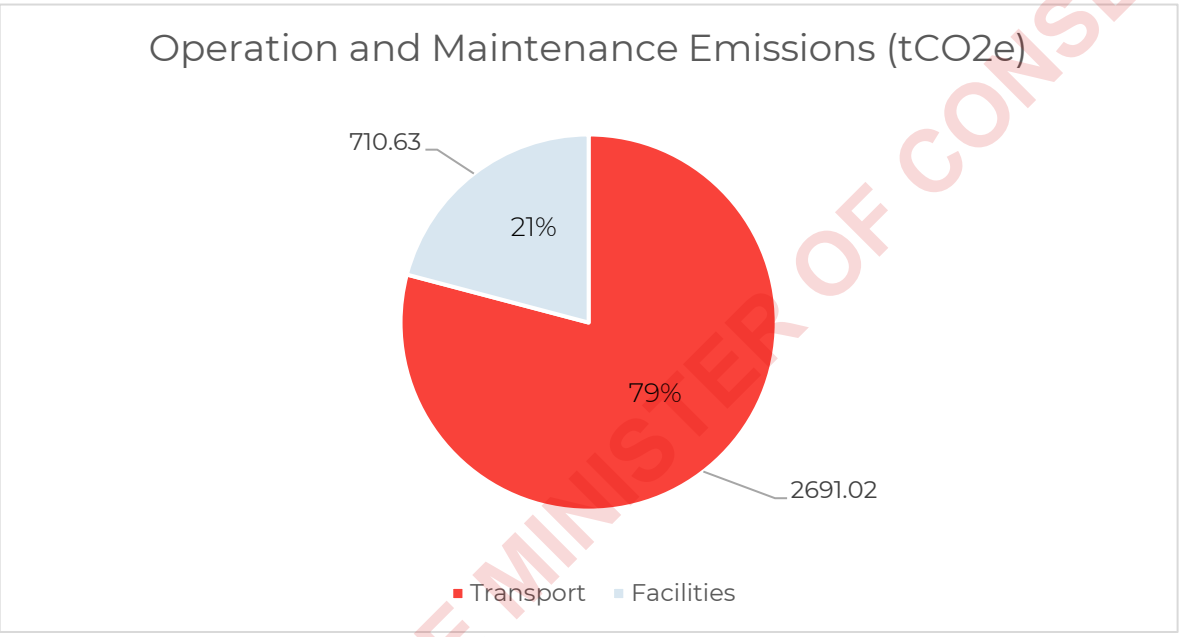

Figure 9 – Total emissions for Operation and maintenance of transport and facilities categories over the 50 year life cycle

4.3 END-OF-LIFE STAGE – LCA MODULE C

The results of the quantified transport and facilities emissions at the end-of-life stage show emissions for the end-of-life material transport of resealing and rehabilitation activities across a 50-year asset lifecycle. Specifically, these emissions result from the transport of waste and materials to the end-of-life facility, and represent the fuel used to transport material offsite.

The project's activities relating to the transport category have a higher contribution to the overall emission profile, likely due to the quantity of transport-related material required (as per the cost estimate) being significantly higher than Facilities. The number of trips of material requiring offsite disposal will also result in higher end-of-life emissions.

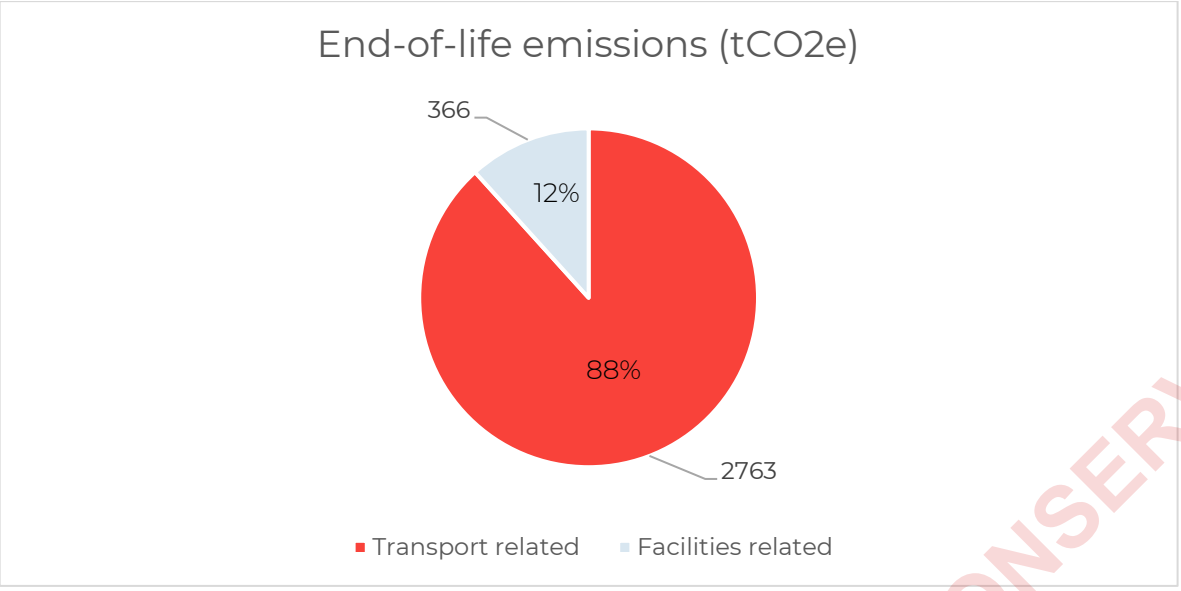

Figure 10 - End-of-life emissions for transport and facilities categories

4.4 STRUCTURES

4.4.1 BACKGROUND

This study follows:

- *ISO 14044: Environmental Management Life Cycle Assessment Requirements and Guidelines.*
- *EN 15978: Sustainability of construction works - Assessment of environmental performance of buildings - Calculation method.*

The impact assessment of the study is limited to those impacts associated with Global Warming Potential (GWP) measured as Greenhouse Gas (GHG) emissions, normalised to a mass of CO_2 equivalent as per IPCC AR6. The functional unit used to compare the proposed and reference building is one (1) m^2 of Gross Floor Area (GFA) over sixty (60) years. Key modules included in this study are modules A to D, with biogenic carbon.

As mentioned above, based on best practice design recommendations according to the GFA calculated for buildings, number of floors are estimated, and the design options are provided. In this initial study, 6, 3, 2 and 1 storey building designs are included. The allocation of scenarios to each building is provided in the 'Structures' sheet of the carbon assessment workbook. The design options will be given in the following sections for each type. Placeholder values and rough estimations will be overwritten where more accurate values are known to the project team.

4.4.2 SUMMARY OF KEY MATERIAL INPUTS

A summary of some of the key materials used in the buildings estimates is given in this section.

Table 3 - Structures key material inputs

Key Inputs Material Category	Concrete	Reinforcement Steel	Structural Steel	Softwood Timber	CLT	LVL	Timber Cladding	Insulation	Plasterboard	Rigid Air Barrier	Fibercement Cladding	Windows	Metal Roof Cladding
Substructure	X	X	X										
Super: EBF, MRF, Steel & Concrete	X	X	X										
Super: Timber & EBF	X	X	X	X	X								
Super: Concrete	X	X	X	X									
Super: Timber	X	X	X		X	X							
Building Envelope: Timber							X	X	X	X		X	X
Building Envelope: Fibercement								X	X	X	X	X	X

4.4.3 LIMITATIONS

Limitations and constraints that impacted the carbon assessment include:

- This LCA study is based on the best available information for the buildings. The LCA modelling includes reasonable but necessary assumptions where information has not been available.
- The life cycle impact results are limited by the detail of the environmental product declarations used and the availability of the background data, as stated above.
- Certain life cycle modules have been omitted from the study either due to detailed data not available, or because their influence relative to other modules is deemed insignificant. Module B is currently excluded from the LCA modelling due to these aforementioned reasons. Due to limited information on these components at the feasibility and business case stage, a total average carbon footprint has been utilized in the calculation (excluding module B), subject to potential variations based on building type, function, and design. The single design scenario incorporating module B pertains to a single-story building, for which only a total GWP has been calculated based on previous projects. Regarding B6 which is operational energy, some rough estimates are given in section 4.2.5.
- Including items within the LCA study is based on the materiality of environmental impact. Where impacts for an item are deemed non-material to the overall life cycle impact of the asset, it may be excluded from the study in line with the requirements of EN 15978 and ISO14044.
- LCA studies depend on available information for the building and available LCA datasets for material selection and sourcing, construction process, energy consumption, pollutants, etc. The modeller must make assumptions in the modelling process.

- The results should only be compared in their own category. That is the design options should only be compared together in 6-storey category not with 3-storey for example. Since they have different included components. In next stages, when the materials and quantities are known the numbers can be compared with different categories as well.

4.4.4 EXCLUSIONS

The following main items are excluded from estimations:

- Building operational water and energy
- Site and landscape
- Any vertical transport, solar, water collection values
- Embodied carbon data for some HVAC building services is not yet available.
- Individual screws, nails and other fasteners that are not part of delivered building products.
- Glues, sealants, caulking compounds and filling compounds used in small quantities throughout the building and not part of delivered building products. (Sealants used in membrane roofs applied on-site must be included in the study.)
- Doorknobs, door hinges, light switches, power sockets and other minor fittings.

4.4.5 OPERATIONAL CARBON

Although the operational carbon is excluded from the scope, it is good to talk about it as a separate topic since it has a big impact on the overall results.

The energy consumption is based on the use of a heat-pump for both heating and cooling of a typical 3 storey office building, according to 2023 Clause H1 rules with thermal bridges removed. As such, the operational carbon resulting from the estimated energy demand, would be around 100 $kgCO_2e/m^2$. This number can increase significantly for different type of buildings. Evidence obtained from previous projects indicates that these energy demand numbers can increase, dependent on the activity within the building, for example to an average of 260 $kgCO_2e/m^2$ for educational buildings and 400 $kgCO_2e/m^2$ for health centres.

Based on these previous studies, removing the thermal bridges and using energy efficient systems have the most important roles in reducing operational energy use and consequent emissions. The number (100 $kgCO_2e/m^2$) can be increased up to 950 $kgCO_2e/m^2$ with thermal bridges and the use of a boiler for heating and air conditioning for cooling.

4.4.6 RESULTS & DISCUSSION

The results of carbon footprint estimations with 10% contingency per GFA of the buildings are presented in the following matrix tables for different design options. The numbers show a rough estimation of $kgCO_2e/m^2$ for each scenario. The results cover modules A to D including biogenic carbon. The green colour shows the better and red colour shows the worse options.

Table 4 - Building envelope emissions by material – 6 storey

	Building Envelope	Timber Cladding		Fibercement Cladding	
6 Storey	Sub/Super	base isolation	pile and ground beam	base isolation	pile and ground beam
	Steel & Concrete	307	376	317	386
	MRF	337	406	347	416
	EBF	298	367	308	377

Table 5 - Building envelope emissions by material – 3 storey

	Building Envelope	Timber Cladding			Fibercement Cladding		
3 Storey	Sub/Super	raft slab	concrete pile	screw pile	raft slab	concrete pile	screw pile
	EBF	529	488	403	541	501	415
	MRF	532	492	406	545	504	418
	Concrete	755	714	628	767	726	640
	timber	218	177	91	230	189	103
	timber & EBF	393	352	266	405	364	278

Table 6 - Building envelope emissions by material – 2 storey

	Sub & Super	Building Envelope	Timber Cladding	Fibercement Cladding
2 Storey	EBF & Raft Slab		131	150

Table 7 - Building envelope emissions by material – 1 storey

		Range	
1 Storey	Steel & Raft Slab & Metal Cladding	667	800

According to the tables above, it can be seen that EBF superstructure with base isolation and timber cladding in 6 storey building scenarios; and timber superstructure with screw piles and timber cladding in 3 storey building scenarios; and EBF with raft slab and timber cladding in 2 storey buildings have the lowest carbon impact. The lowest carbon emissions numbers were expected from scenarios with timber, then timber/steel hybrid designs. It is good to emphasize again that all these numbers rely heavily on big assumptions at this stage due to the high-level study and lack of detailed inputs. However, the results show a consistent trend which aligns with other studies. At this stage when there is no available information around the materials and quantities the estimations based on the previous typical projects has been the only viable approach.

5 DISCUSSION AND CARBON REDUCTION OPPORTUNITIES

From the findings of the initial carbon assessment, the embodied material emissions identify the proposed materials with the highest emissions, and the additional emissions associated with maintenance operations using these materials. Hotspots in each asset category have been identified, as shown below in Table 7.

5.1 MATERIAL HOTSPOTS

Table 8 - Material emission hotspots

KEY MATERIAL HOTSPOTS CATEGORY	TRANSPORT	FACILITIES	3 WATERS	STRUCTURES
Aggregate	X	X		
Asphalt and Sealing Chip	X			
Cut to Waste	X	X	X	X
Structural Steel		X		
Superstructural Steel				X
Steel Bridge		X		
Construction Fuel	X	X	X	X
Concrete Manholes			X	
Concrete Piling				X
Fibercement				X

There are several factors that can reduce the emissions in these hotspots, including reusing materials on site, sourcing local materials, efficient design and construction processes, and exploring material alternatives. Reduction opportunities are further discussed in Section 5.2 below.

5.2 CARBON REDUCTION OPPORTUNITIES

Transport 	-Reuse aggregate on site and/or source as local as possible -Reuse bitumen from the existing runway and paved areas that would otherwise be cut to waste. This would also reduce the virgin fill material required for new activities. -Investigate aggregate substitutions such as glass, rubber crumb and plastics -Increase materials with higher % of SCMs and RAP where feasible -Use a grid connection where feasible or on-site solar considered for stationary plant -Assess bio-bitumen processes for circular economy using waste/recovered products
Structures 	-Use timber where possible, steel/timber hybrid scenarios where timber is not feasible. -Reduce the use of concrete. -Specify steel with lower impact manufacturing process where possible. -Value engineering the super and substructure -Specify more durable and low maintenance materials -Increase the operational efficiency and use of low impact refrigerants - Removing the thermal bridges and using energy efficient systems
3 Waters 	-Assess nature-based solutions and natural water management techniques for feasibility in different drainage networks -Increase local biodiversity and use eco-sourcing, enhance slop stability with NBS e.g. swales instead of underground pipes -Avoid the use of concrete pipes and large concrete drainage components - Reuse materials from existing site for trenching fill for pipelines
Facilities 	-Increase materials with higher % of SCMs and RAP -Set up regional depots for storing and reprocessing of construction waste materials / resources -Use a grid connection where feasible or on-site solar considered for plant -Investigate alternatives for heavy diesel machinery or increased efficiency -Investigate alternatives to structural steel e.g. Glulam, CLT

These opportunities provide a starting point and base for additional quantification as more specific asset and design details becomes available. The results of the carbon assessment should be referenced and carried through this project's lifecycle to implement carbon reductions where possible.

6 NEXT STEPS

As mentioned in Section 2.1 of the report, this assessment is inclusive of proposed infrastructure at the time of receiving the Stage 2 cost estimate (Appendix H) and based on the content of the meetings held as noted above, at the time of assessment.

Section 3.1.2 Exclusions includes items listed (8-20) that will add to the total emissions of the project, and contain potentially material emissions. As stated in Section 3.1.2, these items were excluded due to lack of detail at the time of assessment. It was determined by the carbon assessment team that the assumptions required to quantify these items could lead to an inaccurate emissions estimate. However, these should be included in the next stage of the updated carbon assessment.

A few of these items were discussed between DOC and WSP and identified as project elements that should be quantified to determine the carbon emissions and potentially material impact on the project's emissions profile:

- Wastewater treatment systems and toilets: It is recommended this be reviewed in detail with the wastewater specialist team and the cost estimate team to ensure a robust emissions assessment is complete.
- Cable car: It is recommended this be reviewed with the design team and cost estimate team to determine asset components, sizes, material quantities, and operational requirements.
- Use of helicopters during construction in remote areas: It is recommended this is estimated when activity details are available. This will enable an accurate quantification of emissions from using helicopters and comparison of emissions with alternatives. An initial search shows the difference in fuel consumption rates of helicopters compared to lorry trucks:

Vehicle Type	L diesel/hr	L diesel/100km
Small helicopter[4]	19-76	
Large helicopter[5]	95-4165	
Lorry truck[6]	4.1-8.4	30-40

[4] https://www.aeroclass.org/helicopter-fuel/#:~:text=The%20more%20fuel%2Defficient%20small,%2C%20according%20to%20pilotteacher.com.

[5] https://www.aeroclass.org/helicopter-fuel/#:~:text=The%20more%20fuel%2Defficient%20small,%2C%20according%20to%20pilotteacher.com.

[6] https://www.webfleet.com/en_nz/webfleet/industries/transport/fuel-efficiency/#:~:text=Generally%2C%20a%20truck's%20average%20fuel,of%20course%20use%20less%20fuel.

To quantify the emissions of the excluded items listed (8-20) in Section 3.1.2, the following information at minimum would be required (dependent on asset type and activity):

- quantity and size of asset
- quantity and size of material components
- areas for any proposed site clearing
- construction vehicle types and quantities, and the duration of operation
- size of structural buildings and platforms
- estimate of ground level cuts and fill
- distances travelled (applicable to some construction activities)
- EPD (Environmental Product Declaration) of the gondola or cable car (or an estimate of the main material quantities and weight)

This information will enable further development of the carbon assessment and identify any additional carbon hotspots that have not been quantified in this report.

7 LIMITATIONS

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8 APPENDICES

8.1 APPENDIX A – WSP SUSTAINABILITY SCOPE

Sustainability Scope – Reverse Brief 09012024

MILFORD OPPORTUNITIES PROJECT

1 Climate Risk Assessment

WSP will deliver a long-term climate risk assessment. This high-level desktop assessment will assess the physical climate risks for infrastructure within the Milford Opportunities Masterplan.

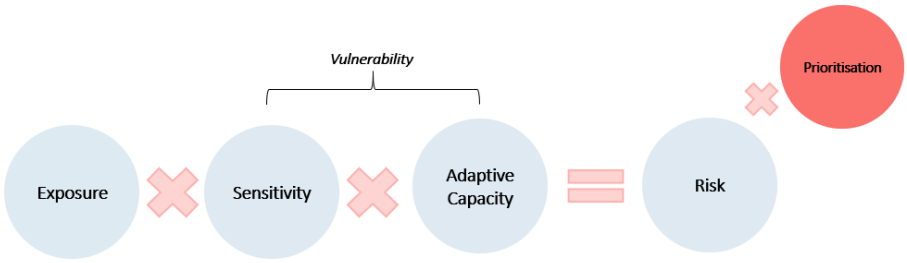
The risk assessment will align with the climate hazards within the localised projections report "Climate Change in Fiordland and Mt Aspiring National Parks", and the Natural Hazard Risk Assessment, if needed. WSP proposes the following climate hazards are assessed:

- Heavy rain days (days > mm rain), assessing for flood risk
- Higher temperatures) days < 1 mm rain), assessing for drought.
- Hot days (days > 25°C), assessing for wildfires, risk to human health and physical assets.
- Frost nights (nights < 0°C), assessing for avalanche (higher freezing level), risk to human health and physical assets.
- Sea level rise (not included in localised projections report)
- High winds and storms – early screening.

The Milford Opportunities Project is in an early planning project phase. We recommend approaching this risk assessment as a preliminary screening by assessing risk only against the high emissions scenario; RCP 8.5. As the project moves into more detailed business case phases, a more robust risk assessment (using both RCP 4.5 and RCP 8.5) can be completed.

National Climate Change Risk Assessment Framework

This desktop screening will align with the National Climate Change Risk Assessment Framework (NCCRA) by following an exposure and vulnerability approach to assessing risk.
A list of 'elements at risk' will be collaboratively developed. Due to the stage of the project, individual assets will not be assessed. Assets will be grouped together into an 'element-at-risk'. The approach to grouping assets will be collaboratively developed with the client and will align with the Masterplan, to reflect the spatial extents, noting that some types of weather events may impact certain infrastructure/areas more than others, e.g topography, types of assets.
Elements-at-risk will be assessed across three timeframes: current day, mid-century (2031-2030, "2040") and late-century (2081-2100, "2090"). By looking at these timeframes we can gain a sense of how risks might intensify across different planning horizons.



Final output

The final output will include:

- Climate risk register - comprising all the elements at risk, assessed against associated climate-related hazards.
- Climate Risk report – a summary of the risks assessment method and overview of the high-priority climate risks that should be prioritised for adaptation planning.

Climate risk assessments evolve over time as projects become more informed and design becomes more detailed. The final report at this phase will provide clarity on the next stage of climate risk assessment which should be completed during the more detailed business case phases.

Phase one: Assessment set up (December)

- Client meeting to confirm risk assessment approach. This will include confirmation of the risk assessment boundary and method.
- Information requests:
- *List of proposed infrastructure in the Masterplan. (Appendix A Scope of Services (Schedule 1) and Appendix 2 to the Stage 2 Infrastructure Assessment Report)*
- *List of existing infrastructure, including what is staying or changing as a result of the Masterplan, if available.*
- *Asset information, including design life and asset criticality where it is known and available, considering readily available information (spreadsheet).*
- Literature review:
- *Climate Change in Fiordland and Mt Aspiring National Parks*
- *Milford Opportunities Masterplan*
- Client meeting to collaboratively develop a list of 'elements at risk' (project components). This will be based on asset types and typography.

Phase one output: clarification of risk assessment method and boundary.

Phase two: Risk assessment (December – January)

- Development of a Milford Opportunities Project climate risk register.
- Using the desktop information provided, WSP will complete climate risk ratings for elements at risk.
- Technical review of climate risk assessment

Phase two output: Draft climate risk register

Phase three: Final report (February)

- Draft final report (1 round of review)
- Final report (Friday 1st March)

Phase three output: Final climate risk register and final long-term climate risk report.

Exclusions

- Geospatial mapping or quantitative analysis included.
- Other cascading risks
- Climate risk workshops are excluded (this is a desktop assessment)

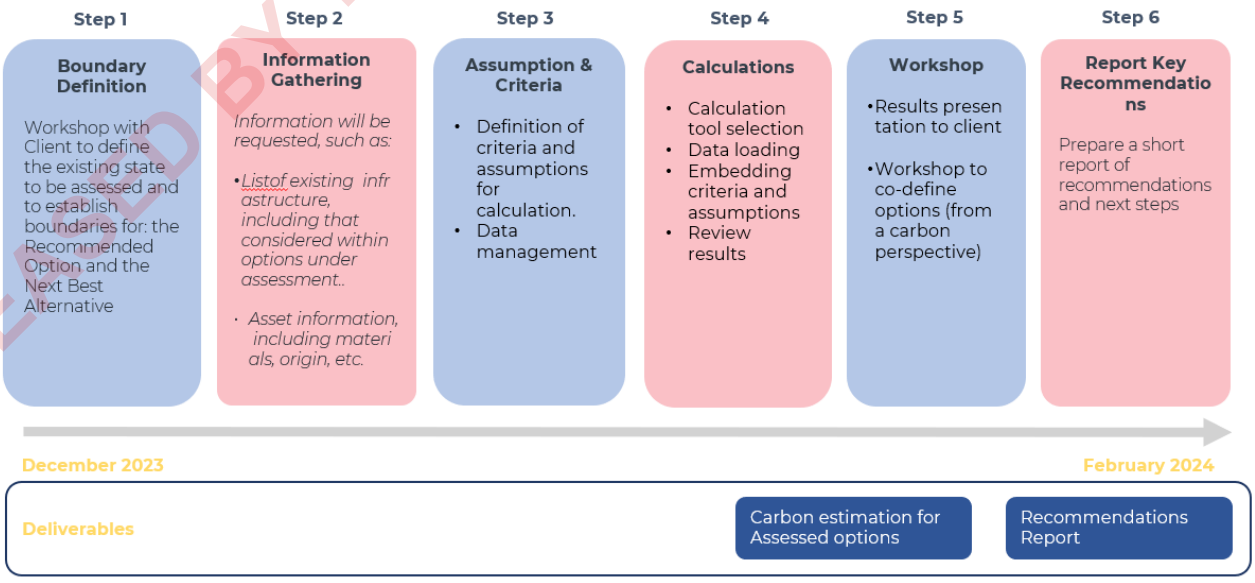
2 Sustainability Scope

Objective

Understand the implications of the development options through a carbon and circular economy lens. Utilise this to provide information for sound decision-making on climate change and carbon impacts of the future development as part of the implementation of the Masterplan.

Methodology

1. Kick off workshop with Client to agree on boundaries and scope of work for the proposed assessment. Embedding a carbon lens into the decision-making process ensuring carbon is a key consideration in defining a recommended option, and the next best alternatives. [December 2023]
2. Information gathering of existing infrastructure details, current and proposed designs for baseline and proposals. [December 2023]
3. HOLD POINT: Based on the available information and boundary definition, a meeting with Beca (delivering enabled emissions from transport and mode shifts) may be required to confirm boundaries of assessments and ensure no double-counting (or gaps).
4. Establishment of assumptions based on project documentation, available information and the defined boundary of the carbon assessment. [January 2024]
5. Calculations using asset information gathered, using carbon estimation tools such as Waka Kotahi's PEET and BRANZ CO2struct. [January 2024]
6. Workshop to present results of carbon assessments, highlight carbon intensive areas and suggest next best alternatives and provide recommendations to reduce carbon and align with the Circular economy aspirations of the Client. The workshop will focus on circular economy thinking both on a whole project basis and with respect to the embodied carbon in buildings and infrastructure development and opportunities for resource efficiency and waste minimisation during planning, design and construction. [Early February 2024]
7. Production of Sustainability Assessment report summarising outputs of the carbon baselining and workshop. A opportunities register will be delivered as part of this which will be a live document for the project to carry through to the next phase. [February 2024]



Key deliverables:

- Development of a carbon footprint for the masterplan infrastructure to include a recommended option and the next best alternative.

- Sustainability Assessment report identifying high-level sustainability opportunities, circular economy opportunities in line with areas and materials that could be considered for lower carbon solutions, which can be developed as part of a decarbonisation programme going forward.

Assumptions

- The carbon assessment will only cover embodied emissions associated with the infrastructure development, for the Existing State, Recommended Option and Next Best Alternative.
- Existing state (baseline) is considered to be the existing infrastructure.
- All carbon emissions calculations will be based on readily available information.
- Only embodied carbon of existing and new infrastructure will be calculated.
- Timings dependent upon receipt of information.

Exclusions

Assessment of enabled emissions from transport mode shifts. The carbon assessment will only cover embodied emissions associated with the infrastructure development.

8.2 APPENDIX B – CARBON ASSESSMENT WORKBOOK

Asset list and assumptions

8.3 APPENDIX C – STRUCTURAL MATERIALS

8.3.1 SUPERSTRUCTURE OPTIONS

8.3.1.1 6_STOREY

EBF: Steel structure with Eccentrically Braced Frames as a lateral force resisting system developed to resist seismic events.
MRF: Steel structure with Moment Resisting Frames as seismic resisting system.
Concrete: Concrete superstructure is commonly used for high-rise buildings
Timber: timber frame with steel core
Timber &EBF: steel/timber hybrid system with Eccentrically Braced Frames

8.3.1.2 3_STOREY

Steel & Concrete: Steel frame with concrete shear wall
EBF: Steel structure with Eccentrically Braced Frames as a lateral force resisting system developed to resist seismic events.
MRF: Steel structure with Moment Resisting Frames as seismic resisting system.

8.3.1.3 2_STOREY

EBF: Steel structure with Eccentrically Braced Frames as a lateral force resisting system developed to resist seismic events.

8.3.1.4 1_STOREY

Steel: An average steel structure with EBF resisting system

8.3.2 SUBSTRUCTURE OPTIONS

8.3.2.1 6_STOREY

Base Isolation: flexible bearings or pads made from layers of rubber and lead between the building's foundations and the structure above.
Pile and Ground Beams: Piled foundations consist of a number of piles connected by a ring of concrete called a ground beam.

8.3.2.2 3_STOREY

Raft Slab: A raft foundation is a reinforced concrete slab under the building.
Concrete Pile: 16 x 0.9m dia x 26m bored piles, with liquefiable layer
Screw Pile: 32 x 9.3 m Screw Piles, with ground beams and slab

8.3.2.3 2_STOREY

Raft Slab: A raft foundation is a reinforced concrete slab under the building.

8.3.2.4 1_STOREY

Raft Slab: A raft foundation is a reinforced concrete slab under the building.

8.3.3 BUILDING ENVELOPE

Timber Cladding: This is a treated wooden cladding for external walls including all wall construction layers and metal roof cladding such as insulation, rigid air barrier, and aluminium joineries.
Fibercement Cladding: This is common in NZ for external wall cladding including all wall construction layers and metal roof cladding the same as above.
Metal Cladding: Metal wall cladding is selected only for one storey building scenario which is a commercial building at port, including the metal roof cladding and other wall construction layers.

8.3.4 OTHER COMPONENTS

As mentioned above, placeholder values are used for internal components and building services. Also, all partition wall frames are assumed to be softwood.

8.4 APPENDIX D – SCOPE CLARIFICATION

Infrastructure Stage 2 cost estimate data – scope clarification with Beca and DOC

Items discussed for scope clarification with WSP, DOC and Beca - 15/02/2024

ID	Location	Category	CBA_Reference	Description	Unit	Unit_Price	Quantity_Max	Comment	Responsible
PDel2	Piopiotahi	Structures	Tracks & observation points	Visitor Protection Refuges	no.	$ 345,000.00	4	Shelter / Refuge for hazards at key locations outside of the key structures (at Fresh Water Basin, Long Stay Parking, Deepwater Basin, Cleddau Delta). Double as infromation centres and potential observation points	WSP
PHub7	Piopiotahi	Structures	Arrival	Structures - Bus Stop - Piopiotahi arrival	no.	$ 345,000.00	1	Shelter / Refuge style of development acting as an arrival point for buses. Located a short distance from the Visitor Experience Hub	WSP
PHub8	Piopiotahi	Structures	Arrival	Structures - Covered Walkway - Piopiotahi arrival	m	$ 1,840.00	170	Covered Walkway from Bus Arrival to Visitor Experience Hub	WSP
PHub5	Piopiotahi	Structures	Marine Centre	Marine Interpretive Centre - Piopiotahi	m^2	$ 5,500.00	950	Facility developed to enhance visitor interaction. Touch pool, working lab, concourse/display area, back of house. Proposed adjacent to or part of Visitor Experience Hub.	WSP
PHub2	Piopiotahi	Structures	Visitor Hub	Visitor Experience Hub - Piopiotahi	m^2		1800	Facility developed to act as the focal point for the overall experience. Ticketing, interactive displays, information, services. Proposed adjacent to or including Marine Interpretive Centre.	WSP
PDW1	Piopiotahi	Structures	Commercial Fishing Port	Structures - Operations - Commercial port	m^2		300	Renewal of the existing building that houses the operations for the Commerical Port	WSP
PHub1	Piopiotahi	Structures	Visitor Hub	Deconstruction - Existing Hub	m^2	$ 140.00	6125	Removal of structures in the central hub to make way for Visitor Experience, Accommodation and Marine Centre	WSP
PFW1	Piopiotahi	Structures	Ferry Terminal	Deconstruction - Ferry Terminal	m^2	$ 140.00	1300	Removal of Structures/Buildings at existing ferry terminal	WSP
PHub6	Piopiotahi	Structures	Staff Accomodation	Deconstruction - Staff Accommodation	m^2	$ 140.00	2850	Removal of Existing Housing and Staff accommodation in preparation for new infrastructure	WSP
PFW2	Piopiotahi	Structures	Ferry Terminal	Ferry Terminal Toilet Block	no.	$ 352,500.00	1	Toilet block with 4-5 pans to replace the facilities currently available at the Ferry Terminal	WSP
PExO2	Piopiotahi	Transport	Aerodrome	Pavements - Taxiway Realignment	m^2	$ 125.00	16000	For Planes - Revised position of taxiway as an extra over sum for the total runway reconstruction (on south side of the runway)	WSP
PDel3	Piopiotahi	Transport	Parking	Pavements - New Parking Area Sealed	m^2	$ 250.00	6000	Long stay parking and ~~bus layover area~~. To be established within the footprint of the existing staff accommodation area.	WSP
								Bus layover area	BECA
PHub9	Piopiotahi	Transport	Road Realignment	Pavements - Realignment (Arrival)	m^2	$ 1,297.50	500	New access into Piopiotahi established to bring the road (as a one way system) onto the alignment of the existing taxiway	WSP
PExO1	Piopiotahi	Transport	Aerodrome	Pavements - Runway reconstruction	m^2	$ 385.50	32000	Remove existing pavement and rebuild the runway, 800m x 20m plus taxiway and terminal area. Elevate 50% of runway, out of the coastal flooding area	WSP
PDel1	Piopiotahi	Transport	Tracks & observation points	Deconstruction - Airport Runway	m^2	$ 131.00	16000	Removal of existing runway and pavement areas. Establish either landscaping features / planting or establish locations for helicopter landings in its place.	WSP
PHub11	Piopiotahi	Transport	Visitor Hub	Deconstruction - Foreshore Carparking	m^2	$ 131.00	5700	Removal of existing carparking and pavement on the foreshore. Establish landscaping features / plantings in its place.	WSP
PDel5	Piopiotahi	Transport	Access Systems	Shuttles - Capital Investment	no.	$ 750,000.00	12	Purchase of shuttles to convey visitors from from Visitor Experience Hub to the ferry terminal.	BECA
	Piopiotahi	Transport	Access Systems	Shuttles	no.	$ 750,000.00	9	Vehicles for movement of visitors from hub to ferry terminal. Low rider, high volume about 8 on constant loop - 75% year 0	BECA
	Piopiotahi	Transport	Access Systems	Shuttles	no.	$ 750,000.00	3	Vehicles for movement from hub to ferry terminal. Low rider, high volume about 8 on constant loop - 25% year 15	BECA
PDel4	Piopiotahi	Transport	Transport Terminal	Shuttles - Base of Operations				Area for the operation and maintenance of shuttles to take visitors from the hub to the terminal. Includes facilities for Bus driver resting, shuttle mainteance, charging and overnight housing	BECA

	Piopiotahi	Transport	Transport Terminal	Shuttles - Base	m^2	$ 190.00	2460	Established adjacent to Long stay parking and bus layover area. To be established within the footprint of the existing staff accommodation area.	BECA
	Piopiotahi	Transport	Transport Terminal	Shuttles - Base	m^2	$ 3,600.00	400	Building / structure for drivers and maintenance	BECA
	Piopiotahi	Transport	Transport Terminal	Shuttles - Base (Generator)	no.	$ 116,840.00	1	Power for charging hubs - Backup generator	BECA
	Piopiotahi	Transport	Transport Terminal	Shuttles - Base (Transformer)	no.	$ 125,250.00	1	Power for charging hubs - Transformer	BECA
CKF11	Corridor	Structures	Knobs flat experience hub	Knobs Flat Flood Protection	m	$ 3,600.00	3000	Stop banks and flood protection structures required for Knobs Flat Accomodation	WSP
CCE8	Corridor	Structures	Short Stops	Bus Shelter - Light	no.	$ 69,800.00	5	Simple shelter either waterproof stretch awning attached between poles in peak season or simple solid roof (site dependant), with a single sealed vault toilet. Internet /wifi / mobile connection allowed for (site dependant)	WSP
CCE9	Corridor	Structures	Short Stops	Bus Shelter - Minor	no.	$ 199,800.00	5	Timber lined structure and interpretation boards. Waterproof stretch side awning attached in peak season to increase capacity, with a single sealed vault toilet. Internet /wifi / mobile connection allowed for (site dependant)	WSP
CCE3	Corridor	Transport	FNP threshold	Corridor Experience - FNP Entrance / Departure	no.	$ 345,000.00	1	Constructed entrance developed along lines of kiosk and remote monitoring	WSP
CCE4	Corridor	Transport	FNP threshold	Corridor Experience - Eglington Reveal Carpark	no.	$ 659,200.00	1	Parking Area at Eglington Reveal- including a robust shelter, 900 m2 parking (unsealed), and 4 vaulted toilets	WSP
CCE1	Corridor	Structures	Homer Tunnel portals	Homer Tunnel - Eastern Portal	no.	$25,000,000.00	1	Expansion of eastern Tunnel Portal for viewing area providing rockfall protection from the southern slopes, and protected pullover area for buses allowing for the visitor experience.	WSP
CTH2	Corridor	Transport	Super track head	Super Track Head - Parking Area	m^3	$ 190.00	500	Super Track Head - Parking for Lake Marian walkway/ trail head. Enhancement of the existing parking area	WSP
TAV3	Te Anau	Structures	Visitor Hub	Structures - Bus Stop - Te Anau Departure	no.	$ 345,000.00	1	Shelter / Refuge style of development acting as a departure point for buses. Located adjacent to the Visitor Experience Hub	WSP
TAV1	Te Anau	Structures	Visitor Hub	Structures - Visitor Experience Hub - Te Anau	m^2	$ 5,000.00	1000	Facility developed to act as the focal point for the overall experience in Te Anau. Ticketing, interactive displays, information, services.	WSP
TAV4	Te Anau	Transport	Visitor Hub	Pavements - Visitor Experience Hub - Te Anau	no.	$ 8,320.00	60	Parking provided for drop off and short term carparking and for Bus Transfers. Allowance for the equivalent of 60 vehicle parks	WSP
TAV8	Te Anau	Transport	Visitor Hub	Carriageway - Visitor Experience Hub - Te Anau	m	$ 1,730.00	1000	Allowance for the realignment of roadways in the vicinity of the visitor hub and intersection upgrades for the movement of buses etc within Te Anau. Scope would require definition based on final selected location	WSP
TAB3	Te Anau	Transport	Access Systems	Buses - Capital Investment	no.		156	Selected bus infrastructure for the conveyance of visitors to and from Piopiotahi	BECA
	Te Anau	Transport	Access Systems	Buses - Phase 1	no.	$ 750,000.00	78	Vehicles for movement from Te Anau to Piopiotahi - 50% year Zero	BECA
	Te Anau	Transport	Access Systems	Buses - Phase 2	no.	$ 750,000.00	39	Vehicles for movement from Te Anau to Piopiotahi - 25% year 10	BECA
	Te Anau	Transport	Access Systems	Buses - Phase 3	no.	$ 750,000.00	39	Vehicles for movement from Te Anau to Piopiotahi - 25% year 20	BECA
TAB1	Te Anau	Transport	Transport Terminal	Buses - Base of Operations				Area for the operation and maintenance of buses to take visitors from Te Anau to Piopiotahi. Includes facilities for Bus driver resting, bus mainteance, charging and overnight housing	BECA
	Te Anau	Transport	Transport Terminal	Buses - Base of Operations - Parking	m^2	$ 259.00	14980	Housing of shuttles and buses - includes allowance for charging hubs	BECA
	Te Anau	Transport	Transport Terminal	Buses - Base (Generator)	no.	$ 116,840.00	0	Power for charging hubs - Backup generator	BECA
	Te Anau	Transport	Transport Terminal	Buses - Base (Transformer)	no.	$ 125,250.00	1	Power for charging hubs - Transformer	BECA
	Te Anau	Transport	Transport Terminal	Buses - Base of Operations - Building	m^2	$ 3,600.00	1200	Building / structure for drivers and maintenance	BECA
TAB2	Te Anau	Transport	Transport Terminal	Pavements - Park and Ride - Te Anau	no.	$ 8,500.00	1000	Car Parking (Spaces) for Park and Ride. To be established adjacent to the Base of Operations for buses to make use of shared facilities, and to optimise the use of the pavement areas (peak season the bus storage area can be used for overflow parking)	BECA

8.5 APPENDIX E – INFRASTRUCTURE ASSETS

Request for Proposal – MOP Engineering Feasibility Assessment – Appendix A – Schedule 1

Appendix A - Schedule 1:

Location	Description
Te Anau	Te Anau Hub
Henry Creek Campsite	Bus Shelter
Te Anau Downs	Bus Shelter
Node 1 FNP Entrance	
	Road Layout
Node 2 Eglington Reveal	
	Visitor Shelter & Toilet
	Road layout
	Car park
Mirror Lakes Short Stop	
	Bus Shelter & Toilet
	Road Layout
Node 3 Knobs Flat incl Kiosk Ck	
	Potable Water Assessment
	Wastewater Assessment
	Accommodation at Knobs Flat
	Camping layout
	Visitor Shelters
	Accommodation at Kiosk Creek
	Short walks – supporting infrastructure
	Te Anau Downs to Cascade Ck – supporting infrastructure
Node 4 Cascade Creek	
	Camping layout
	Flood protection infrastructure
	Car park
	Bus Shelter
	Potable Water Assessment
	Wastewater Assessment
	Facilities for kayaking
	Overnight experience (s) – supporting infrastructure
Node 5 Whakatipu Trails Head/The Divide Short Stop	
	Lk Marian Visitor Shelter/Wananga & Toilets
	Lk Marian Car park
	Lk Marian Road layout
	Lk Marian Loop, covered walkway, connection to The Divide, Key Summit to Cascade Creek – supporting infrastructure
	The Divide Car park and Visitor Shelter
Node 6 Gertrude Valley	

	Visitor Shelter
	Road layout
	Car park
	Flood protection infrastructure
	Gertrude Valley Walk – supporting infrastructure
Node 7 Cleddau Cirque	
	Road layout
	Car park
	Rockfall shelter
Chasm Short Stop	
	Road layout
	Car park
	Bus Shelter & Toilet
Piopiotahi Visitor Hub	
	Potable Water Assessment
	Wastewater Assessment
	Visitor accommodation
	Staff accommodation
	Visitor hub building
	Road layout
	Bus terminal incl arrival gathering space
	Structures - Covered walkway
	Foreshore enhancements incl water-based viewing deck
	Car park
	Barren Pk Spur walk – supporting infrastructure
	Structures - Barren Pk Treetop Viewing
Freshwater Basin Node	
	Cable car or similar 'lift'
	Bowen Falls/Valley walks – supporting infrastructure
	Structures - viewing platform upper falls
	Structures - floating pontoon, viewing platform lower falls
	Nature walk loop – supporting infrastructure
	Boat terminal
	Refuge
Cleddau Delta Node	
	Aerodrome Removal
	Regenerative landscape spine
	Cleddau Delta walks – supporting infrastructure
	Structures - Water based viewing deck, Delta Link Bridge
	Refuges
Deepwater Basin Node	

	Car park and bus layover area
	Boat Ramp
	Facilites for kayaking
	Refuge
	Heliport incl Little Tahiti option
Miscellaneous	
	Milford Sound to Tutoko Historic Bridge Walkway – supporting infrastructure
	The Chasm to Cleddau Horse Bridge – supporting infrastructure

8.6 APPENDIX F – COMMENTS REGISTER

MOP Carbon Assessment – v1 Comments Register

ID	Date	Doc	Section	Highlight	Reviewer	Comment	Degree	Resolving	Resolved Comments	Date	Status
1	3/11/2024	SM TH Comments	2.1	Appendix A:	TH	Please reference a bit more clearly: WSP's Scope of Service		Claire	Added in as Appendix A.	3/14/2024	Resolved
2	3/11/2024	SM TH Comments	2.1	*Stage 2 Cost Estimate*	TH	Please reference a bit more clearly: Stage 2 Infrastructure Assessment Report Appendix 2 Cost Estimates for Infrastructure Proposals		Claire	Amended	3/11/2024	Resolved
3	3/11/2024	SM TH Comments	2.1	Confirmation of the scope and boundary ... attached in Appendix A	TH	Appendix A is a list of structural elements/materials types...not a summary of the scope discussion with Beca		Claire	Amended to Appendix D	3/11/2024	Resolved
4	3/11/2024	SM TH Comments	2.1		SM	Tom - are you comfortable with this statement?		Claire	Added clarification in S2.1 to distinguish Beca's scope of transport-related emissions assessments vs what is included in WSP's carbon assessment	3/14/2024	Resolved
5	3/11/2024	SM TH Comments	2.1		TH	Not entirely - there are some transport related infrastructure assets that Beca are calculating embodied emissions for - just needs clarifying here, i.e. explain that Beca is assessing enabled emissions and park and ride system related embodied emissions as part of the Transport System & Design Contract.		Claire	Added clarification in S2.1 to distinguish Beca's scope of transport-related emissions assessments vs what is included in WSP's carbon assessment	3/14/2024	Resolved
6	3/11/2024	SM TH Comments	2.2	Diagram	SM	A key for A, B, C, D Or add a footnote referencing Table 1 (though that doesn't distinguish between the numbered classes		Claire	Added *Table 1* with more detailed descriptions of each module	3/11/2024	Resolved
7	3/11/2024	SM TH Comments	3	Transport	TH	This statement is correct in that Beca are also using PEET for their assessment of transport infrastructure emissions?		Claire	This statement refers to the categorisation followed in the cost estimate, which broke down the cost estimate items into four different categories; Transport, Facilities, 3 Waters and Structures. Added clarification this follows what is in Appendix B. Also added clarification of what Transport items are in this scope vs Beca's.	3/11/2024	Resolved
8	3/11/2024	SM TH Comments	3	List item 2	TH	Can we get a copy of your workings please, so we can make this available to future stages of the project?		Claire	Will attach as Appendix B	3/11/2024	Resolved
9	3/11/2024	SM TH Comments	3	List item 3	SM	cross ?		Claire	Amended	3/11/2024	Resolved
#	3/11/2024	SM TH Comments	3	List item 6	SM	WSP ?		Claire	Amended (was not referring to the enabling of emissions)	3/11/2024	Resolved
#	3/11/2024	SM TH Comments	3.1.1	Assumption 1	TH	Is it possible to do this in consultation with the structural team now they have a better handle on what this will look like?		Claire	If more detail is now available, this should be quantified at the next stage when the carbon assessment is next updated. This report reflects the information received available at the time of report completion.	3/11/2024	Resolved
#	3/11/2024	SM TH Comments	3.1.1	Assumption 3	TH	That's interesting! So we can't demonstrate the benefits of recycling these materials??		Claire	Yes. From this baseline, adding supplementary mixes and lower-emission materials, along with reusing and recycling materials cut or existing site materials will demonstrate emission reductions. Not including these is considered BAU for NZ as the availability of these can be location and supplier dependent.	3/11/2024	Resolved
#	3/11/2024	SM TH Comments	3.1.1	Assumption 5	TH	As above, can we please have a copy of this with the final deliverable?		Claire	Yes, attached in Appendix B	3/11/2024	Resolved
#	3/11/2024	SM TH Comments	3.1.1	Assumption 9	SM	(A4) ?		Claire	Clarified in Table 1	3/11/2024	Resolved
#	3/11/2024	SM TH Comments	3.1.1	Assumption 9	SM	Still not sure what A1 - A5 actually means		Claire	Clarified in Table 1	3/11/2024	Resolved
#	3/11/2024	SM TH Comments	3.1.1		TH	Relates to Simon's comment above - can you plse provide a key explaining what A (1-5) and B (...) etc mean?		Claire	Clarified in Table 1	3/11/2024	Resolved
#	3/11/2024	SM TH Comments	3.1.2	*Exclusions*	TH	At present you also have the cable car excluded from the assessment, although I'd like to think you can cover this now?		Claire	This was discussed with the project design team and relayed to PM that WSP does not currently have sufficient detail to quantify the cable car (meeting held to clarify with Ian Sutherland on 22/02/2024). If more detail is now available, this should be quantified at the next stage when the carbon assessment is next updated. This report reflects the information received to date of the report completion.	3/11/2024	Resolved
#	3/11/2024	SM TH Comments	3.1.2	Intro sentence	SM	Tom ?					Unresolved
#	3/11/2024	SM TH Comments	3.1.2	Exclusion 2	TH	Clarify what this is? assume Pipiotahi? If so, can we bring this into scope now that we have the assessment of existing/potential hydro power from Stantec?		Claire	Added clarification this refer to Piopiotahi Power Cabling. If more detail is now available, this should be quantified at the next stage when the carbon assessment is next updated. This report reflects the information received to	3/14/2024	Resolved
#	3/11/2024	SM TH Comments	3.1.2	Exclusion 3	TH	At Te Anau?		Claire	Yes at Te Anau. Our workbook provides confirmation of this and other Transport-related items that were exluded as they are covered in the Beca assessment.	3/14/2024	Resolved
#	3/11/2024	SM TH Comments	3.1.2	Exclusion 15 - Potable Water Storage	TH	Where?		Claire	Cost estimate indicates this as the 'Corridor' location. The unit and quantity were 'no.' '1' and did not have enough information at the time of assessment to be able to estimate the emissions. This can be assessed at the next stage of carbon assessment.	3/14/2024	Resolved
#	3/11/2024	SM TH Comments	3.1.2	Exclusion 16 - Kiosk Creek Accom	TH	Wastewater treatment and disposal at this site would be included within the Knobs Flat WwTP		Claire	As operational emissions were added into scope near the end of this initial carbon assessment, we have a wastewater treatment specialist who could complete a more in-depth emissions assessment for wastewater treatment facilities at the next stage of assessment. There was no detail on the wwt facility and process and therefore could not be estimated at this stage.	3/14/2024	Resolved
#	3/11/2024	SM TH Comments	3.1.2	Exclusion 18 - Potable Water Council Connection (Hub)	SM	no - development contributions required		Claire	This was referring to the full name of the line item in excel. I will remove the second part of it with the 'development contributions' to make it more clear	3/11/2024	Resolved
#	3/11/2024	SM TH Comments	3.1.2		TH	WSP team - to clarify, development contributions are not currently required		Claire	This was referring to the full name of the line item in excel. I will remove the second part of it with the 'development contributions' to make it more clear	3/11/2024	Resolved

#	3/11/2024	SM TH Comments	3.1.2	Additional exclusions sentence	SM	does this list constitute a material gap? If so, what is proposed to address it? If not, there should be a statement to that effect noting that they will either be added in from the Beca report or that they are a relatively small proportion of the of carbon in the list of items that are covered.		Claire	I have amended the first part of the exclusions to be more clear on which items are excluded because they are covered in Beca's report. The rest of the items were listed in the Stage 2 Cost Estimate as an item but had no material or quantity breakdown. Yes, these may constitute a material gap depending on size and material types, however it was considered innacurate to develop	3/14/2024	Resolved
#	3/11/2024	SM TH Comments	4.1.1	construction	TH	consumption?		Claire	Amended to 'consumption'	3/11/2024	Resolved
#	3/11/2024	SM TH Comments	4.1.1	end of parag.	SM	could the milling and 'reuse' of bitumen from the runway (if it was to be removed) for new carparks be one way of reducing the carbon footprint of two activities? (not in reseal but in fill material, reduced disposal cartage etc Are there opportunities like that which could be noted? Later on I see they have section 5.2 - a reference to that section here would be useful		Claire	Great point. I've added a note that reduction opportunities for this are discussed in Section 5.2, and I've added more detail to the Transport decarb section.	3/11/2024	Resolved
#	3/11/2024	SM TH Comments	4.1.1	Figure 3 caption ***cite***	TH	spelling - 'site'		Claire	Amended	3/11/2024	Resolved
#	3/11/2024	SM TH Comments	4.1.2	Intro sentence	TH	Where these facilities are inaccessible by road then helicopters are used to transport materials. What effect does this have on emissions? Also as far as type/quantity is concerned I assume that this is based on the Walking & Cycling Feasibility Assessment Report? In addition, the proposed backcountry hut and associated facilities is missing from this assessment and is likely a contributor worthy of inclusion.			The backcountry hut and associated facilities are not included as an item in the Stage 2 cost estimate which informed our assessment. If more detail is now available, this should be quantified at the next stage when the carbon assessment is next updated. This report reflects the information received to date of the report completion. Yes, the Walking & Cycling Feasibility Assessment was used for rough dimensions on track details, along with the Stage 2 Cost Estimate Reference tab info.	3/14/2024	Resolved
#	3/11/2024	SM TH Comments	4.1.3	3 Waters Emissions blurb	SM	is there no estimate that can be used based of previous work i.e. an MBR capable of treating wastewater for 8000 people/day peak volume (assuming 25% buffer for either growth or infiltration)? This would at least be a better starting point even with caveats than having a gap.		Claire	As operational emissions were added into scope near the end of this initial carbon assessment, we have a wastewater treatment specialist who could complete a more in-depth emissions assessment for wastewater treatment facilities at the next stage of assessment. The original sustainability scope (Appendix A only included embodied emissions, not operational).	3/14/2024	Resolved
#	3/11/2024	SM TH Comments			TH	WSP team - as with the cable car your 3 waters team has advanced their thinking about system type and size required at Knobs Flat and Milford Sound, is it possible to pick up on that? The other sites are all proposed to be total containment with frequent emptying, so materials emissions and transport emissions associated with operating & maintenance		Claire	As operational emissions were added into scope near the end of this initial carbon assessment, we have a wastewater treatment specialist who could complete a more in-depth emissions assessment for wastewater treatment facilities at the next stage of assessment. The original sustainability scope (Appendix A only included embodied emissions, not operational).	3/14/2024	Resolved
#	3/11/2024	SM TH Comments	4.1.3	Figure 7-8 info	SM	thinking of the location and extent of the networks at the relevant sites is this really a valid statement? are manholes not typically steel plates (noting that this would be a bigger number than concrete)?		Claire	Good point, not necessarily concrete contributing the most to these emissions. I amended this in the report and confirmed that these have been quantified as a Manhole item in PEET, which assumes: *Concrete manhole with standard 600mm dia hole, 1.2m riser and flanged base with cast iron lid and reinforcing*	3/11/2024	Resolved
#	3/11/2024	SM TH Comments	4.1.3	Figure 8	SM	Need to give this a bit more thought with respect to where we are talking about or at the very least a bit more context			Added sentence in 3 Waters 4.1.3 intro with the assumption from PEET to clarify the manhole emissions	3/14/2024	Resolved
#	3/11/2024	SM TH Comments	4.2	Intro blub	SM	is 3 waters not in here because their network and treatment facility design lives are typically greater than 50 years? What about elements of an MBR such as the membranes, etc?		Claire	At the time of assessment there was no material or quantity breakdown of the wastewater treatment infrastructure (besides what is quantified in the report). This should be added in the next stage of the carbon assessment when more information is available. As operational emissions were added into scope near the end of this initial carbon assessment, we have a wastewater treatment specialist who could complete a more in-depth emissions assessment for wastewater treatment facilities at the next stage of assessment.	3/11/2024	Resolved
#	3/11/2024	SM TH Comments	4.2	Intro blub *'higher compared to facilities…'*	TH	Need to acknowledge servicing of remote locations that require the use of helicopters, particularly the proposed backcountry hut. DOC has done some work on this in the past that may be easy to tap into.		Claire	Operational emissions, which would include this servicing, were exlcuded from the original scope (Appendix A). If more detail is now available, this should be quantified at the next stage when the carbon assessment is next updated. This report reflects the information received to date of the report completion.	3/11/2024	Resolved
#	3/11/2024	SM TH Comments	4.2	Figure 9	SM	is this an annualised figure?		Claire	This is total for 50 years. Text has been amended to clarify this.	3/11/2024	Resolved
#	3/11/2024	SM TH Comments	4.3	Intro blurb *'a'*	TH	Delete		Claire	Amended	3/11/2024	Resolved
#	3/11/2024	SM TH Comments	4.4.1	*and T he impact'*	TH	Lower case please		Claire	Amended	3/11/2024	Resolved
#	3/11/2024	SM TH Comments	4.4.3	*Limitations*	TH	Need to insert some paragraph breaks in this section.		Claire	Amended	3/11/2024	Resolved
#	3/11/2024	SM TH Comments	4.4.3	*B1, B5, B6 and B7 …*	TH	Just want to clarify this - are you referring to MOP being in the preliminary design stage (which its not) or is it just not standard practice to include these materials at the feasibility and then preliminary design stages b/c there isn't enough info available?		Zara	Removed 'Prelim' and added 'Stage'. B6 and B7, which are operational energy and water, can be added in later stages if the energy and water demand becomes available.	3/12/2024	Resolved
#	3/11/2024	SM TH Comments			SM	Are there 'typical' estimates that can be noted a such and used?		Zara	A placeholder number is given for B6 (operational energy). No number is available for other modules and these modules are optional in many assessments.	3/12/2024	Resolved
#	3/11/2024	SM TH Comments	4.4.5	*Operational Carbon*	TH	Again insert para break(s) please		Claire	Amended	3/11/2024	Resolved

#	3/11/2024	SM TH Comments			SM	what is considered to be the source of the carbon being counted?		Zara	This number is based on a study done by WSP/HERA/BRANZ which is not published yet, however the is for office building. I think it is good to add an average of 4 other types of buildings we have from previous projects. Althought it will be a range not an average. Based on the previous projects educational facilities had an average around 260 kgco2/m2/annum and health centers around 400 kgco2/m2/annum and office based on the study mentioned above is 100 kgco2/m2/annum.	3/12/2024	Resolved
#	3/11/2024	SM TH Comments	4.4.6	blurb below Table 6	TH	It would be interesting to understand if this option is feasible from a structural perspective for larger buildings at Milford Sound Piopiotahi - have you cross referenced with the civil/structural team?		Zara	The suggestions for 6 storey, 3 storey, 2 and one are different. So significantly larger buildings might be different. These options are designed by structural engineers.	3/12/2024	Resolved
#	3/11/2024	SM TH Comments			SM	???		Zara	rewriten: Apparently, the lowest carbon emissions numbers were expected from scenarios with timber, then timber/steel hybrid designs.	3/12/2024	Resolved
#	3/11/2024	SM TH Comments			SM	are elements from other studies able to be used as estimates where there isn't design to work from at this point?		Zara	All our estimates are based on previous projects with typical designs. At this stage where there was no available infomation around the materials and quantities this has been the only viable approach.	3/12/2024	Resolved
#	3/11/2024	SM TH Comments	5.1	*Section 7.2*	SM	5.2 ?		Claire	Amended	3/11/2024	Resolved
#	2/28/2024	PSD Comments	Glossary	*CO2-e*	PSD	(assume highlighted as inconsistent with CO2e used later)		Claire	Amended to CO_2e	3/11/2024	Resolved
#	2/28/2024	PSD Comments	Glossary	*Embodied Emissions*	PSD	Add enabled emissions to glossary		Claire	Added to glossary	3/11/2024	Resolved
#	2/28/2024	PSD Comments	Glossary	Greenhouse gases (GHGs) *'(CO)'*	PSD	CO2		Claire	Amended to CO2	3/11/2024	Resolved
#	2/28/2024	PSD Comments	1.1	*Milford Opportunities* ***p*** *roject*	PSD	(assume highlighted to change to capital P)		Claire	Amended	3/11/2024	Resolved
#	2/28/2024	PSD Comments	1.2	3rd parag. *'by Milford Opportunities'*	PSD	'the' MOP		Claire	Amended	3/11/2024	Resolved
#	2/28/2024	PSD Comments	3.1.1	Assumption 1 *'with the exception of the cable car…'*	PSD	better in 'exclusions'?		Claire	Moved to exclusions	3/11/2024	Resolved
#	2/28/2024	PSD Comments	3.1.1	Assumption 4	PSD	exclusions		Claire	Moved to exclusions	3/11/2024	Resolved
#	2/28/2024	PSD Comments	3.1.2	formatting	PSD	Numbered list for consistency with previous section, or table.		Claire	Amended to numbered formatting	3/11/2024	Resolved
#	2/28/2024	PSD Comments	4.1.1	*fuel construction*	PSD	this doesn't make sense		Claire	Amended to 'consumption'	3/11/2024	Resolved
#	2/28/2024	PSD Comments	4.1.2	Figure 4 A1-A3 *tCO2e*	PSD	(highlighted as units are shown in addition to lifecycle stage - remove the units)		Claire	Amended	3/11/2024	Resolved
#	2/28/2024	PSD Comments	4.1.3	Intro blurb *As identified in the* ***assumptions*** *section*	PSD	exclusions		Claire	Amended	3/11/2024	Resolved
#	2/28/2024	PSD Comments	4.4.1	Background	PSD	mass of **CO2** equivalent		Claire	Amended	3/11/2024	Resolved
#	2/28/2024	PSD Comments	4.4.1	Background	PSD	m2		Claire	Amended	3/11/2024	Resolved
#	2/28/2024	PSD Comments	4.4.1	Background	PSD	A_D		Zara	A to D	3/12/2024	Resolved
#	2/28/2024	PSD Comments	4.4.5	Operational Carbon	PSD	kgCO2eq/m2 (inconsistent)		Claire	Amended	3/11/2024	Resolved
#	2/28/2024	PSD Comments	4.4.5	Operational Carbon	PSD	kgCO2eq/m2 (inconsistent)		Claire	Amended	3/11/2024	Resolved
#	2/28/2024	PSD Comments	4.4.6	Results and Discussion	PSD	kg CO2eq/m2 (inconsistent)		Claire	Amended	3/11/2024	Resolved
#	2/28/2024	PSD Comments	4.4.6	Results and Discussion - tables	PSD	Assume the colour-coding relates to better/best (green) and worst (red) but this should be clarified.		Zara	Yes the Green shows the best and red shows the worst scenario.	3/12/2024	Resolved

8.7 APPENDIX G – EMISSIONS SUMMARIES

Emissions summaries for each type of asset category estimated are shown below for Module A Lifecycle Stages. The materials contributing some of the highest emissions in each category are highlighted in red. The quantification and breakdown of the Structures asset category were assessed using a different methodology than the Transport, 3-Waters and Facilities category assets. The total structures emissions (tCO2e) are detailed within the report Section 4.4.

Table 9 - Embodied emissions (A1-A3) by material type – Transport category assets

Material type	tCO_2e
AC, HMA, 5% virgin bitumen (Hot Mix Asphalt)	409.92
Aggregate	366.66
Cut to waste	0.27
Sealing chip	86.40
Total emissions (A1-A3)	863.25

Table 10 - Embodied emissions (A1-A3) by material type - 3-Waters category assets

Material type	tCO_2e
Manholes 1050mm	32.43
PE Pipes 125mm	15.63
PE Pipes 75mm	9.85
Concrete, 30 MPa, precast	1.62
Total emissions (A1-A3)	59.53

Table 11 - Embodied emissions (A1-A3) by material type - Facilities category assets

Material type	tCO_2e
110mm PE Pipe and Trench	1.77
AC, HMA, 5% virgin bitumen (Hot Mix Asphalt)	26.10
Aggregate	706.75
AT steel pedestrian overbridge	19.16
Clearance of High Shrubs and Medium dense trees	2.79
Cut to waste	13.08
Sealing chip	0.30
Small Aluminium Single Post	11.14
Structural Steel	2,272.58
Timber	31.64
Timber Boardwalk	52.45
Total emissions (A1-A3)	3,137.75

Table 12 - Total emissions for transport of materials to site (A4) by category

Asset Category	tCO_2e
Transport	97.27
Facilities	353.55
3 Waters	6.71
Total emissions (A4)	457.94

Table 13 - Total emissions for fuel and energy used on site (A5) by category

Asset category	tCO_2e
Transport	584.33
Facilities	928.07
3 Waters	17.6
Total emissions (A5)	1,531.10

Table 14 - Total emissions (A1-A5) by category

Asset category	tCO_2e
Transport	1,544.85
Facilities	4,419.37
3 Waters	83.85

8.8 APPENDIX H – COPY OF THE COST ESTIMATE