Department for Transport

Local Transport Infrastructure Carbon Benchmark Tool – User Guide

Version 2

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Contents

Terminology used

The following terms are used throughout this document:

- **Greenhouse gases (GHGs)**: gases that by absorbing heat in our atmosphere contribute to global warming. Carbon dioxide accounts for the majority of GHG emissions, although methane, nitrous oxide, hydrofluorocarbons, perfluorocarbons, sulphur hexafluoride and nitrogen trifluoride are also present.
- **Carbon**: shorthand for carbon dioxide equivalent of all greenhouse gases, usually measured in units of tonnes of carbon dioxide equivalent (tCO2e).
- **Carbon impact:** refers to the effect that proposed interventions and/or policies have on carbon emissions, measured in tCO2e.
- **Lifecycle stages:** consecutive and interlinked stages of a product, equipment or service, from raw material acquisition or generation from natural resources to design, production, transportation/delivery, use, end-of-life treatment, and final disposal [Source: PAS 2080:2023, paragraph 3.32 (definition of ‘life cycle’)].
    - See Table 1 below for a summary of lifecycle stages.
- **Capital carbon:** emissions associated with scheme construction [Source: Transport Analysis Guidance (TAG) Unit A3, paragraph 4.2.11].
- **Operational carbon:** emissions associated with scheme operation and maintenance [Source: Transport Analysis Guidance (TAG) Unit A3, paragraph 4.2.11]. Note: While TAG defines operational carbon as inclusive of maintenance, other sources (e.g. RICS Whole Life Carbon Assessment) consider operational carbon to include energy and water use only.
- **User carbon:** emissions associated with scheme users, such as changes in emissions due to mode shift [Source: Transport Analysis Guidance (TAG) Unit A3, paragraph 4.2.11].
- **Infrastructure carbon:** emissions associated with the construction, operation, and maintenance of an infrastructure asset. This includes capital and operational carbon but excludes user carbon.
- **Authorities:** used throughout this report to refer to local or regional authorities responsible for local transport planning (e.g., Local Transport Authorities).
- **Local Transport Plan (LTP):** a document that sets out a Local Transport Authority’s strategic direction and policies pertaining to transport planning; typically, a 10–15-year programme.
- **Intervention category:** a broad collection of intervention types, e.g. active travel.
- **Intervention type:** an infrastructure asset or scheme implemented to achieve a desired transport outcome, e.g. cycle lanes, bridges.

- **Bill of Quantities (BoQ):** A table which lists all elements featured in the design of a scheme, including the materials and respective dimensions and quantity of each element, typically developed to calculate a cost estimate for the scheme.
- **Functional unit:** a common unit of measurement for a particular intervention, material, or activity, that provides a common basis for comparison, e.g. square metres of a rail station.
- **Carbon intensity:** the measure of carbon intensity relative to a functional unit of a particular intervention, material, or activity, in units of tCO2e per functional unit, e.g. tCO2e per square metre.
- **Carbon Cost Ratio (CCR):** the relationship between carbon impact (tCO2e) and direct works cost (£) for a given intervention.
- **Direct works cost:** the costs of implementing an intervention, including labour, materials, and construction, but excluding indirect costs such as project management, consultancy fees, design costs, surveys, or risk/optimism bias allowances, operating, maintenance, or renewal costs.

Lifecycle stage	Definition	Alignment to TAG definitions of capital, operational, and user carbon
Product stage	Carbon emitted during the supply and transport of raw materials and product manufacturing, consistent with **carbon modules A1 (Raw materials supply), A2 (Transport)** and **A3 (Manufacturing)** as defined in BS EN 17472:2022 and PAS 2080:2023.	**Capital carbon**
Construction process stage	Carbon emitted during the transport of materials and installation process, consistent with **carbon modules A4 (Transport)** and **A5 (Construction – Installation process)** as defined in BS EN 17472:2022 and PAS 2080:2023.	**Capital carbon**
Use stage	Carbon emitted during the use (B1), maintenance (B2), repair (B3), replacement (B4), and refurbishment (B5) of the infrastructure, as well as operational energy (B6) and water (B7) use, and user's utilisation of the infrastructure (B8), consistent with **carbon modules B1-B8** as defined in BS EN 17472:2022 and PAS 2080:2023. **NOTE:** While 'use stage' carbon typically includes carbon modules B1-B8, the LTICBT provides a high-level estimate of maintenance (B2), repair (B3), and replacement (B4) impacts only.	**Operational carbon (B1-B7)** **User carbon (B8)**
End of life stage	Carbon emitted during the deconstruction, transport, waste processing, and disposal stages of the infrastructure lifecycle, consistent with **carbon modules C1-C4** as defined in BS EN 17472:2022 and PAS 2080:2023.	**Capital carbon**

Table 1 – Lifecycle Stages

1. Introduction

- This user guide provides advice on how to use the Local Transport Infrastructure Carbon Benchmark Tool (LTICBT), a spreadsheet-based tool published by the Department for Transport (DfT) to support Local Transport Authorities in estimating infrastructure carbon impacts of transport interventions.

- The LTICBT makes use of a 'benchmarking' approach to infrastructure carbon assessment, providing a proportionate means of assessing impacts at the strategic and early concept stages of transport scheme development, in the absence of detailed design information.

- The benchmarking approach employed in the LTICBT allows the user to approximate the infrastructure carbon impact of transport interventions by means of comparison with similar schemes, or typical design specifications. Several examples of each intervention type are embedded within the LTICBT, against which a proposed intervention can be compared. These examples of each intervention type are referred to in this guide and the LTICBT itself as *benchmarks*.

- **The LTICBT is intended primarily to support Authorities to estimate the infrastructure carbon impacts of schemes in early stages of development, such as Local Transport Plans (LTPs) and early stages of business case and appraisal. Typically, at these stages, schemes may be poorly defined and lack suitable detail for a bottom-up assessment of infrastructure carbon.** This ensures that decision making at early stages of scheme development such as this can be well-informed of, and influenced by, infrastructure carbon impacts.

- The LTICBT may also be useful in assessing the infrastructure carbon impacts of proposed schemes at later stages of development, however, should never be used as a replacement for detailed, bottom-up, scheme-specific analysis. Greenhouse gas assessments undertaken as part of a business case for transport schemes should always follow the approach outlined in Transport Analysis Guidance (TAG) Unit A3.

- Note that the benchmarking approach to infrastructure carbon assessment employed in the LTICBT can be referred to as a 'top-down' approach. This approach offers a high-level estimate of infrastructure carbon impacts by way of comparison with typical carbon impacts per functional unit taken from past schemes or design standards/ guidance. This contrasts with the 'bottom-up' approach employed in more detailed assessments (such as those supporting transport scheme business cases as per

TAG Unit A3, and/or in compliance with EN 17472:2022) that typically utilise Bills of Quantities (BoQs).

- Figure 1 outlines appropriate and inappropriate stages of transport scheme development to use the LTICBT for infrastructure carbon assessment.

- The user guide is structured as follows:

  - Section 2 sets out the structure of the LTICBT.
  - Section 3 explains how to use the LTICBT with a hypothetical use case.
  - Section 4 provides details of key features of the LTICBT and their operation.
  - Section 5 outlines known limitations of the LTICBT.
  - Section 6 provides answers to anticipated frequently asked questions.

- An overview of the intervention types and benchmarks featured in the LTICBT, with detailed assumptions and specifications used to develop benchmarks, is available in **Annex A.**

- A detailed description of the methodologies used to develop the benchmarks which are embedded within the LTICBT is available in **Annex B.**

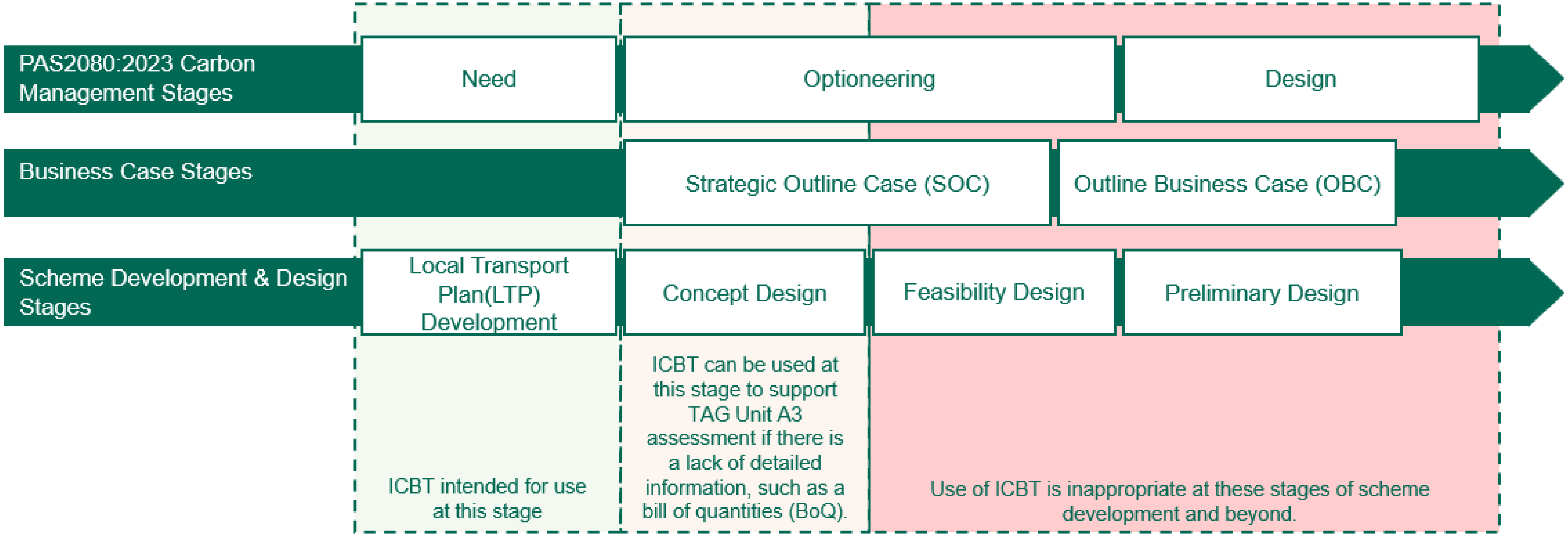


Figure 1 - Intended uses of the LTICBT

2. Structure of the LTICBT

- The LTICBT is a Microsoft Excel spreadsheet-based tool with the following visible worksheets:

  - **Cover-Sheet** – provides version control, table of contents and contact details.
  - **I-User Input** – all user inputs required to conduct an assessment in the tool are made on this worksheet, and summarised guidance is provided to prompt users.
  - **C-Background Data** – contains carbon benchmarks, emission factors, and other details supporting background calculations.
  - **O-Summary** – summarises the inputs and outputs of the assessment in tabular format, providing a breakdown of emissions by intervention, lifecycle stage, and intervention category.
  - **O-Dashboard Comparative** – presents assessment outputs in graph format, comparing the infrastructure carbon impact of individual interventions, and their respective cumulative carbon impact over time.
  - **O-Dashboard Totals** – presents assessment outputs in graph format, showing total emissions by lifecycle stage, intervention category and total cumulative carbon impact over time.

- Several sheets are locked for editing by default. These include formulas that simplify the user interface, particularly on the I-User Input sheet, and should not be altered by users.

- The model map in Figure 2 illustrates the linkages between the background data, inputs, calculations, and outputs of the LTICBT.

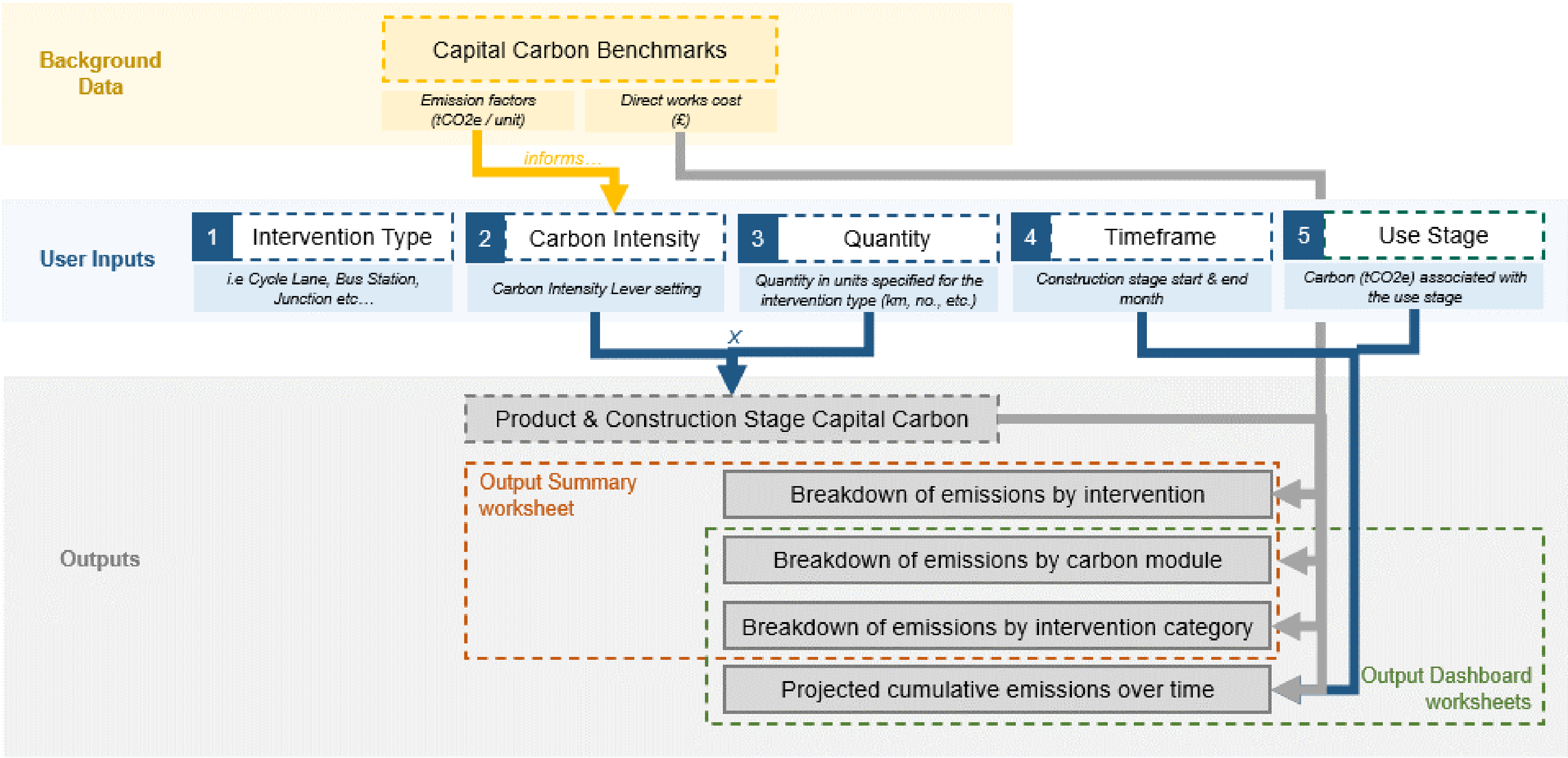


Figure 1 - Model map of the Infrastructure Carbon Benchmark Tool

3. A Step-by-step guide to completing an assessment using the LTICBT

3a. General introduction

- The process to complete an assessment in the LTICBT consists of four steps, all of which can be completed in the I-User Input worksheet. These four steps are summarised in Figure 3 and are detailed throughout this section.

Figure 2 - Summary of LTICBT assessment process

- As introduced in Section 1, the LTICBT is designed to support Local Transport Authorities in estimating infrastructure carbon impacts of transport interventions.

- For clarity, an 'intervention' may refer to:

  - An entire scheme, in cases for which it is possible to categorise the entirety of the scheme as a single intervention type in the LTICBT. Most applicable for smaller-scale schemes.

  - Components or segments of a scheme that is made of up several intervention types. For instance, a bus station improvement scheme may incorporate station enhancement, upgrades to cycle infrastructure, and new parking facilities. Another example may be a mobility hub scheme, which can be assessed by quantifying the constituent elements, e.g. bike/scooter docking station, bike parking stands, EV charging facilities, crossings, etc. These components can be assessed as separate interventions, as described in more detail in section 4e.

  - Components or segments of a scheme that is made up of a single intervention type, however, it varies in carbon intensity. For instance, a cycle lane scheme might include ‘light segregation’ and ‘fully segregated’ cycle lanes throughout its length. In such cases, these components can be assessed as separate interventions.

- One of multiple options being considered for a proposed scheme, which will be compared against each other, rather than assessed cumulatively. Refer to section 3c for additional guidance on which output(s) to refer to in this case.

3b. Familiarisation with the I-User Input Worksheet

- Inputs can be made in any cell shaded in blue. All other cells are not editable.
- The I-User Input worksheet consists of 10 *input lines* and 4 *input sections*, as shown in Figures 4 and 5. Input lines and sections are delineated by the grey-shaded areas.
- Each input line can be used to assess a single intervention, or to assess components of an intervention separately. Up to 10 interventions can be assessed, allowing a programme of schemes to be assessed in one workbook. Please see section 3.8 for further information.
- It is possible to complete an assessment using fewer than ten input lines – the LTICBT will still produce outputs if at least one input line is populated. If more than 10 input lines are required, multiple spreadsheets can be used and outputs summed together.
- In each input line, cells should be populated from left to right, across the four input sections. All four input sections are required to be populated in order to produce the graphics on the output dashboards and obtain meaningful insights.
- The four input sections correspond to the four steps required to assess an intervention. Intermediate outputs are provided between some of these inputs sections.

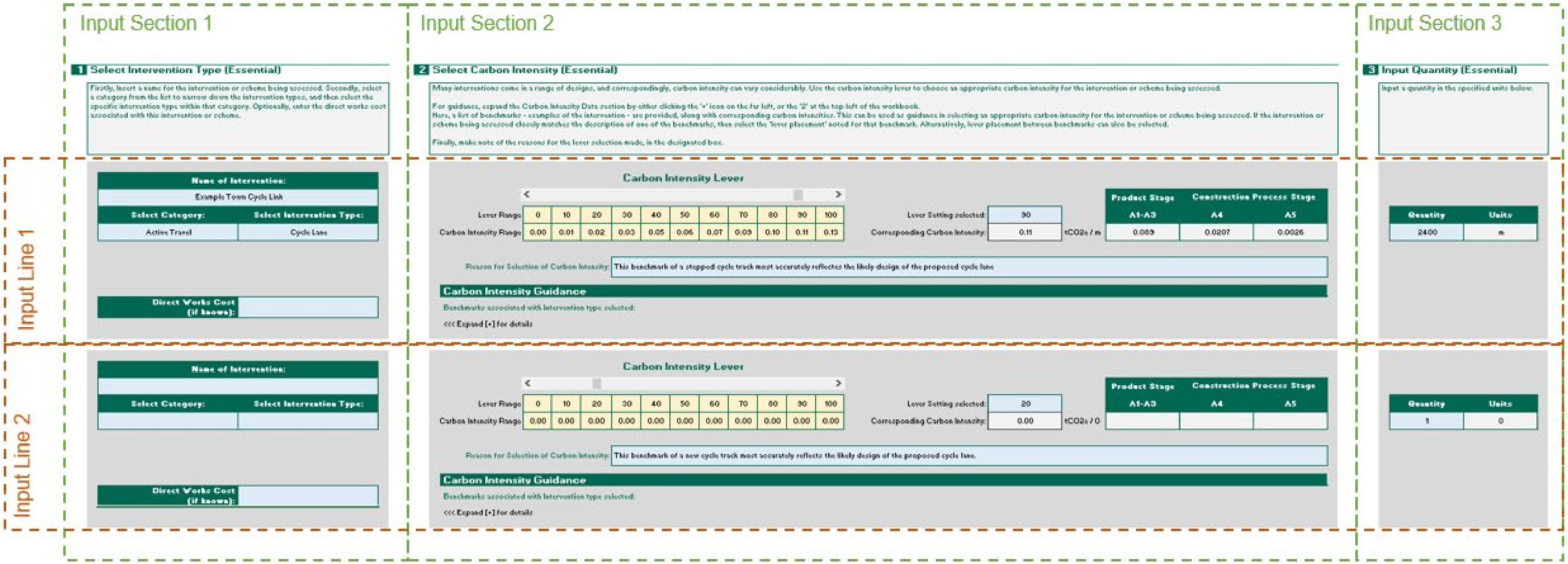


Figure 3 - I-User Input worksheet layout (Sections 1-3)

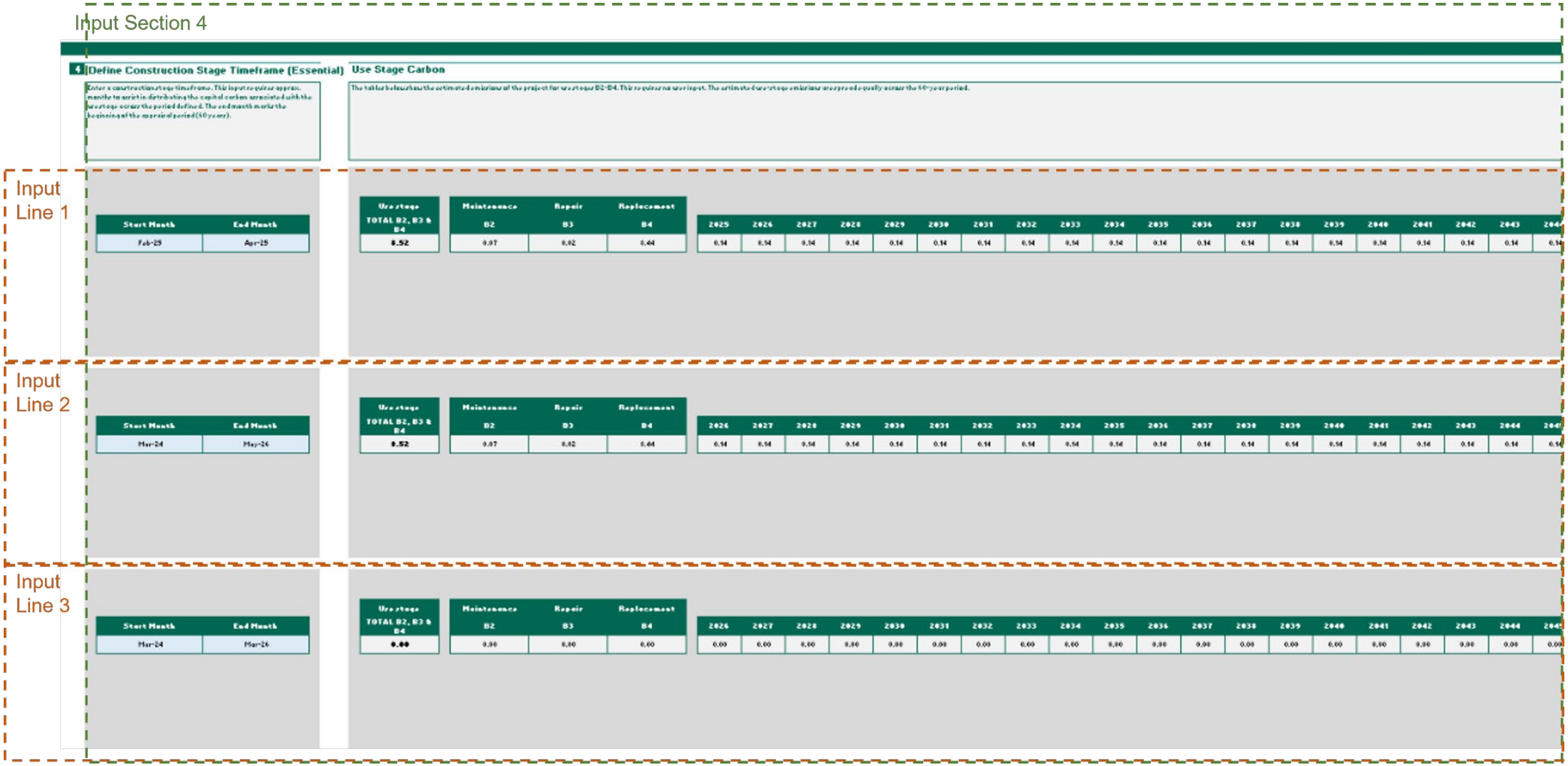


Figure 4 - I-User Input worksheet layout (Section 4)

3c. LTICBT Inputs & Hypothetical Worked Example

- As outlined in Section 1, the primary intended purpose of the LTICBT is to support estimation of infrastructure carbon impacts of schemes and interventions featured in LTPs and early stages of scheme development. The following steps demonstrate how to undertake an assessment using the LTICBT.

Each step is demonstrated using a hypothetical cycle improvement scheme, as shown in text boxes such as this one.

The hypothetical cycle improvement scheme includes implementation of cycling infrastructure between two suburban centres, approximately 1.5km apart. It has the following key details:

- *Along 1.2kms of the corridor, the carriageway width can accommodate installation of high quality, stepped cycle lanes by narrowing existing general traffic lanes.*
- *Some short sections, totalling about 100m of the route, are too narrow to accommodate both traffic lanes and fully protected cycle lanes. In these cases, modal filtering will be used to exclude motorised traffic from the carriageway.*
- *The route also includes a 200m-long section of disused rail corridor which can be converted into a new cycle track.*
- *The scheme is expected to be operational in 2025.*

Step 1. Select Intervention Type

- The first step, completed in the first input section, is to identify what type of intervention is proposed, and to check whether it is featured in the LTICBT. To do this, the user should first navigate to the I-User Input worksheet, and locate the leftmost input section, entitled ‘Select Intervention Type’.

It would be advisable to consider assessing the hypothetical cycle scheme in segments. We will first consider the 1.2km segment of the corridor that can accommodate installation of high quality, stepped cycle. We will return to the narrow (100m) and disused rail corridor sections (200m) afterward, as they are likely to have different carbon intensities.

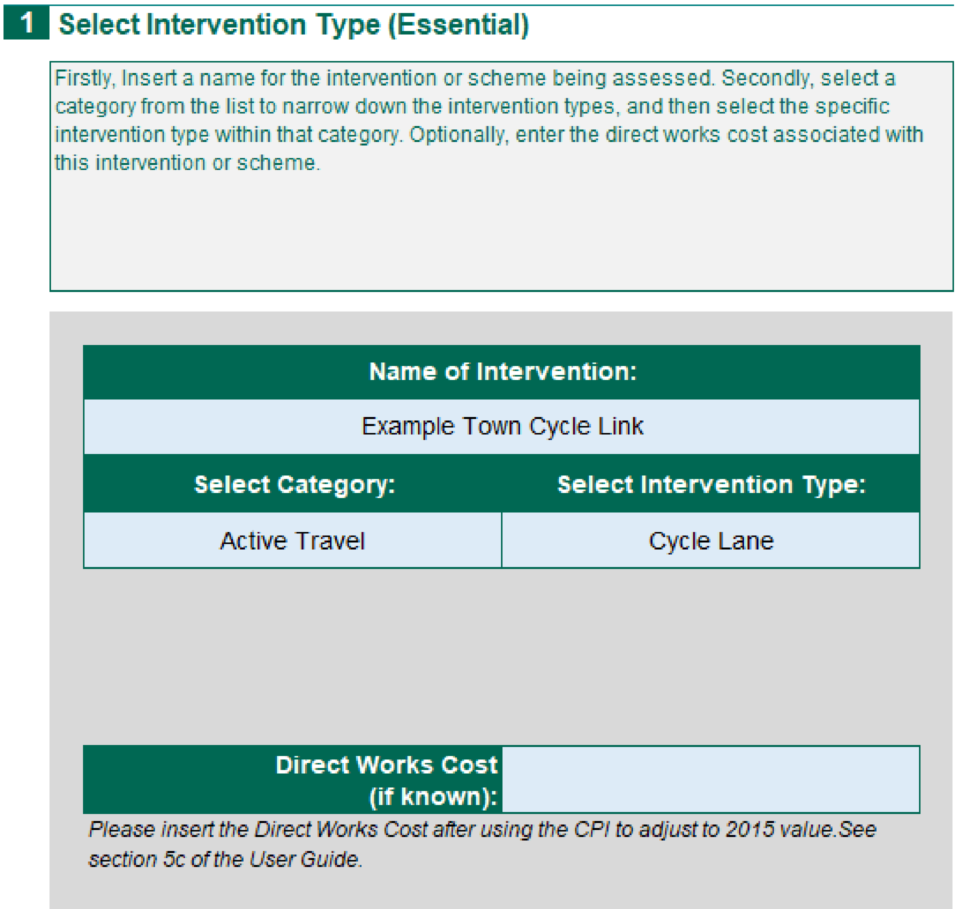


Figure 5 - The leftmost input section on the I-User Input worksheet, ‘Select Intervention Type’

- A name for the intervention being assessed must be inserted under the ‘Name of Intervention’ header. This aids in later reporting of the outputs of the tool. The intervention name must be unique – be mindful that you should name interventions so that they can be easily identified and differentiated in outputs. If assessing different options for a scheme, it is advisable to include the nature of each option (e.g. light segregation vs fully segregated cycle lanes). If assessing similar schemes in multiple locations, it is advisable to include the location in the title.

A suitable name for the 1.2km segment of the cycle scheme might be ‘Alberton-Highwood cycle link – stepped cycle lanes segment’.

- A drop-down menu can be accessed by selecting the cell under ‘Select Category’.

In this case, as the scheme is a cycle improvement scheme, the ‘Active Travel’ category is selected.

- The most appropriate intervention type can then be selected from the cell under ‘Select Intervention Type’.

In this case, 'Cycle Lane' is selected.

- If assessing an intervention that falls under the Highway Treatment category, the following process is slightly different. For details, see section 4c.

- Inputting the Direct Works Cost is optional, but if known, should be entered here to enable the Carbon Cost Ratio (CCR; see Intermediate Output 2) to be calculated based on this value. If Direct Works Cost is not entered, the CCR will be calculated based on benchmark cost values.

- The direct works cost **should be deflated to a 2015 value** using the consumer price index (CPI) and **should not include indirect costs** such as project management, consultancy fees, design costs, surveys, or risk/optimism bias allowances, operating, maintenance, or renewal costs. Further detail on deflating costs to 2015 values is provided in section 4d.

Step 2. Select Carbon Intensity

- This step is key to the benchmarking process. The intention is to establish an appropriate carbon intensity for the proposed intervention by considering how it compares with benchmarks embedded in the tool.

- Remember, it may be appropriate to separate an intervention into components if carbon intensity varies.

- Expand the 'Carbon Intensity Guidance' section in the input row by clicking on the '+' symbol on the far left, as per Figure 6.

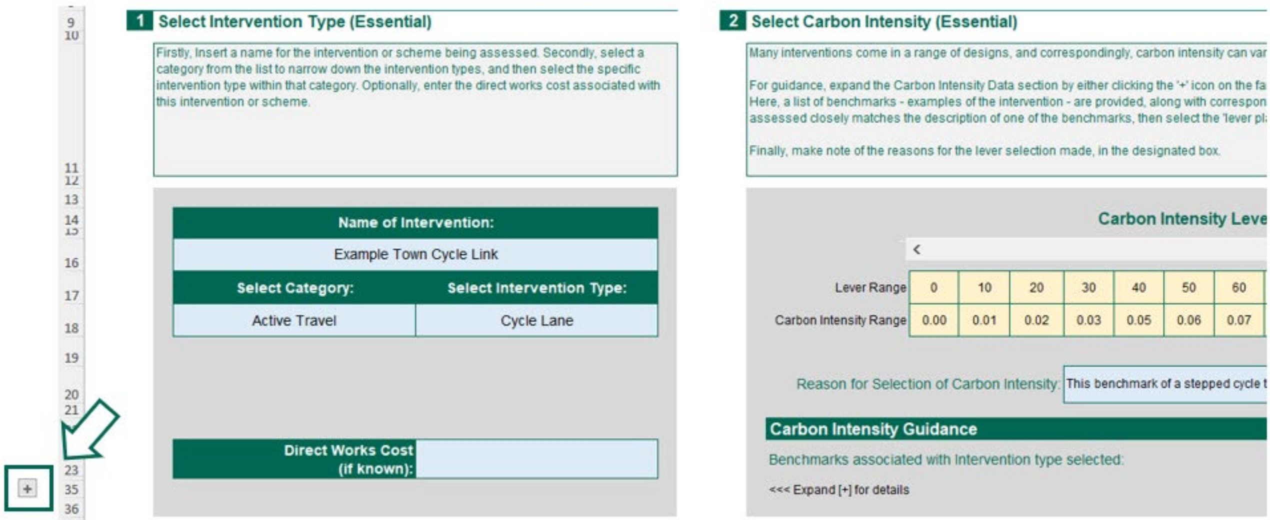


Figure 5 – Input Sections 1 and 2 of an Input Line

- The expanded section reveals a table of benchmarks embedded in the LTICBT for the intervention type selected in Step 1, as per Figure 7.

There are four benchmarks embedded in the tool for cycle lanes. These benchmarks represent the range of standard designs for cycle lanes, from 'light segregated' (simple delineation of a cycle lane using lane markings and marker posts) to 'stepped cycle track' (construction of 2m-wide stepped cycle lane raised 75mm above the carriageway).

Carbon Intensity Lever

Lever Range	0	10	20	30	40	50	60	70	80	90	100
Carbon Intensity Range	0.00	0.01	0.02	0.03	0.05	0.06	0.07	0.09	0.10	0.11	0.13

			Product Stage	Construction Process Stage	
			A1-A3	A4	A5
Lever Setting selected:	0				
Corresponding Carbon Intensity:	0.00	tCO2e / m	0.000	0.0000	0.0000

Reason for Selection of Carbon Intensity:

Carbon Intensity Guidance

Benchmarks associated with Intervention type selected:

Approximate Lever Placement	Benchmark ID	Benchmarks (Cycle Lane)	A1-A5 Carbon Intensity (tCO2e/m)	Description (see Capital Carbon Summary Sheets for full specifications)
10	CL1	Light segregation	0.01	Minimum cycle lane provision - delineation of a 2m-wide one-way cycle lane with marker posts, intermittent microsurfacing asphalt, and road markings.
48	CL3	Fully kerbed cycle track	0.06	Construction of a 0.5m-wide, 0.15m-tall buffer kerb, creating a 2m-wide one-way cycle lane separated from general traffic. Includes intermittent Microsurfacing Asphalt and road markings.
84	CL2	Stepped cycle track	0.10	Construction of a 2m-wide stepped one-way cycle lane raised 75mm above the carriageway (typically a further step of approx. 75mm exists up to footway level), includes intermittent microsurfacing asphalt and road markings.
90	CL4	Cycle track (new track)	0.11	Construction of a 3m-wide bi-directional cycle track independent of any existing carriageway.

Figure 6- List of benchmarks for the selected intervention type (in this case, Cycle Lanes)

- Notice that the carbon intensity guidance tables in the LTICBT provide basic information about each benchmark, including the benchmark ID and name, the carbon intensity, corresponding approximate lever placement (i.e. where the benchmark falls on the carbon intensity lever), and a high-level description of the specifications and attributes of the benchmark. More detailed information regarding each benchmark, including full specifications, assumptions, inclusions, and exclusions, can be found in Annex A.

- The user should now compare the proposed intervention to the benchmarks shown in the table, to determine which benchmark it most closely aligns with. Annex A provides additional detail on benchmarks if further guidance is required. Once it has been determined which benchmark best represents the proposed intervention, the user should use the 'approximate lever placement' in the lefthand column of the table to guide their selection of carbon intensity. The carbon intensity can either be selected by dragging the Carbon Intensity Lever to the desired setting (or can be inputted directly into blue cell to the right of the Carbon Intensity Lever rather than dragging the lever itself). Further detail on the Carbon Intensity Lever can be found in Section 4b.

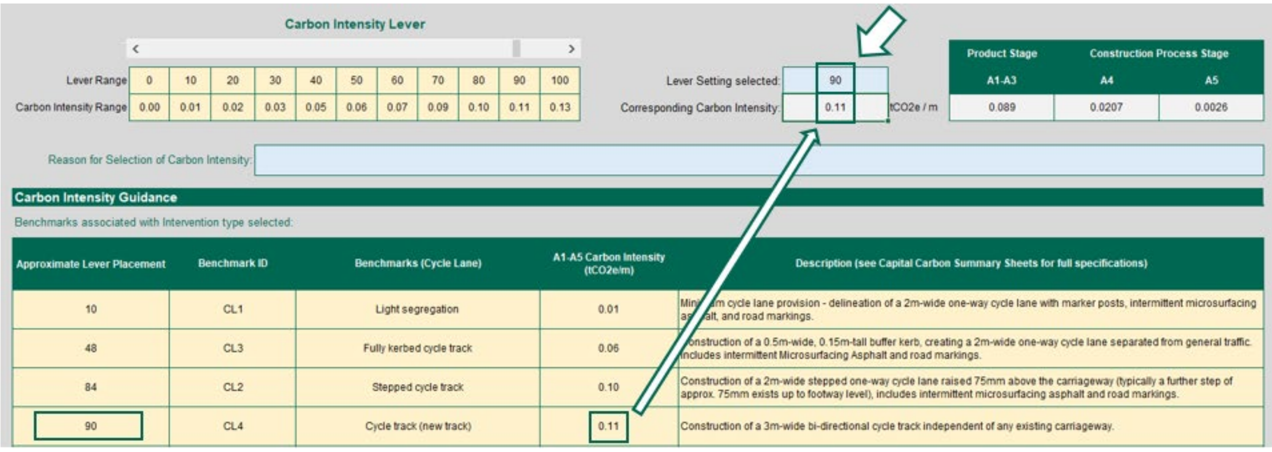
After consulting the 'Carbon intensity guidance' table, it is determined that the most suitable lever placement for this section of cycle lane corresponds with the 'stepped cycle track' benchmark. As the 'stepped cycle track' is the most carbon intensive benchmarks of those provided it corresponds to a lever placement of '90' (for more information on lever placement see section 4b).

- In cases where the intervention being assessed does not exactly match the specifications of one of the embedded benchmarks, the lever allows flexibility to select either an intermediate setting (i.e. between benchmarks) or a setting higher/lower than the most/least carbon intensive benchmarks. For example, if the proposed intervention is likely to be more carbon intensive than the 'light segregation' benchmark but less intensive than the 'fully kerbed' benchmark, the user can select a lever placement between 10 and 64.

- If available information is insufficient to determine an intermediate carbon intensity, it is advisable to select the worst-case scenario, which represents the highest carbon-intensive benchmark of those being considered, for the assessment.

- As per Figure 8, once a lever setting is selected, the corresponding carbon intensity is reflected in the cell below. To the right, this carbon intensity is broken down into emission factors for the Product Stage [A1-A3], and Construction Process Stages [A4 & A5].

For the stepped cycle track, 0.11 tCO2e/m is the carbon intensity reflected.



Carbon Intensity Lever

Lever Range	0	10	20	30	40	50	60	70	80	90	100
Carbon Intensity Range	0.00	0.01	0.02	0.03	0.05	0.06	0.07	0.09	0.10	0.11	0.13

Lever Setting selected: 90

Corresponding Carbon Intensity: 0.11 tCO2e / m

Product Stage	Construction Process Stage	
A1-A3	A4	A5
0.089	0.0207	0.0026

Reason for Selection of Carbon Intensity:

Carbon Intensity Guidance

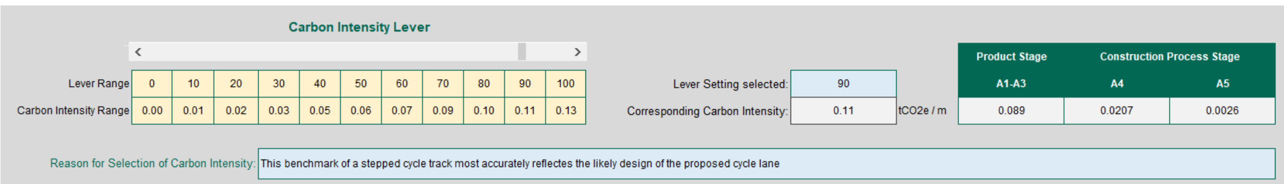
Benchmarks associated with Intervention type selected:

Approximate Lever Placement	Benchmark ID	Benchmarks (Cycle Lane)	A1-A5 Carbon Intensity (tCO2e/m)	Description (see Capital Carbon Summary Sheets for full specifications)
10	CL1	Light segregation	0.01	Mini[illegible]m cycle lane provision - delineation of a 2m-wide one-way cycle lane with marker posts, intermittent microsurfacing as[illegible]alt, and road markings.
48	CL3	Fully kerbed cycle track	0.06	[illegible]onstruction of a 0.5m-wide, 0.15m-tall buffer kerb, creating a 2m-wide one-way cycle lane separated from general traffic. Includes intermittent Microsurfacing Asphalt and road markings.
84	CL2	Stepped cycle track	0.10	Construction of a 2m-wide stepped one-way cycle lane raised 75mm above the carriageway (typically a further step of approx. 75mm exists up to footway level), includes intermittent microsurfacing asphalt and road markings.
90	CL4	Cycle track (new track)	0.11	Construction of a 3m-wide bi-directional cycle track independent of any existing carriageway.

Figure 7 – Carbon intensity lever at setting 90, with corresponding carbon intensity shown below.

- Users are strongly encouraged to populate the 'reason for selection of carbon intensity' with a statement of justification for the lever placement chosen. Justifying the lever placement promotes transparency in the assessment methodology and allows an audit trail to understand the decision-making process behind the carbon intensity evaluation.

A simple note is sufficient in the case of the stepped cycle track, such as "This benchmark of a stepped cycle track most accurately reflects the likely design of this segment of the proposed cycle lane."



Carbon Intensity Lever

Lever Range	0	10	20	30	40	50	60	70	80	90	100
Carbon Intensity Range	0.00	0.01	0.02	0.03	0.05	0.06	0.07	0.09	0.10	0.11	0.13

Lever Setting selected: 90

Corresponding Carbon Intensity: 0.11 tCO2e / m

Product Stage	Construction Process Stage	
A1-A3	A4	A5
0.089	0.0207	0.0026

Reason for Selection of Carbon Intensity: This benchmark of a stepped cycle track most accurately reflectes the likely design of the proposed cycle lane

Figure 8 – Populated justification for lever placement chosen

- Providing a statement of justification is particularly important in cases where a carbon intensity lever setting that does not reflect one of the embedded benchmarks is selected. Users are encouraged to use the benchmarks provided to inform selection of a carbon intensity, but in instances where an alternative, more fitting benchmark has been identified through independent analysis of previous bottom-up assessments, users may use this as evidence for a particular lever setting and may note this in the statement accordingly.

Step 3. Input Quantity

- In the third input section, the approximate quantity or value of the proposed intervention should be inputted in the units shown, as per Figure 10.

The cycle lane is anticipated to extend 2,400 metres in length, as it is proposed in each direction along a 1.2 km stretch of carriageway.

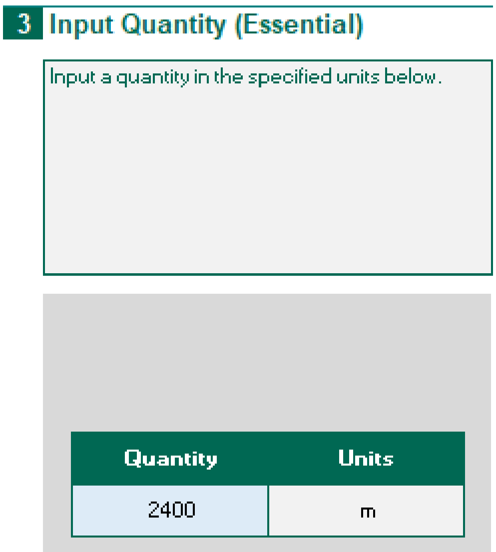


Figure 9 – Input Quantity section

- Table 2 shows the functional units and abbreviations used for benchmarks in the LTICBT. These functional units are used to relate a base quantity of an intervention to tonnes of carbon dioxide equivalent (tCO2e) in emission factors, i.e. X tCO2e/m = X tonnes of carbon dioxide equivalent per metre.

Unit	Abbreviation	Description
Metre	m	Used for benchmarks of linear items such as roads, cycle lanes, or bus lanes, i.e. tCO2e/m, where m = length of intervention in metres.
Square metres	m2 (or m^2)	Used for highway treatment benchmarks, i.e. tCO2e/m2, where m2 = area of highway treatment in square metres.

Number	no.	Used for benchmarks of discrete items such as crossings or bus stops, i.e. tCO2e/no., where no. = number of items.
Space	space	Used for car parking benchmarks, i.e. tCO2e/space, where space = one car parking space.
Stand	stand	Used for bus station benchmarks, i.e. tCO2e/stand, where stand = one bus parking facility (stop or stand).

Table 2 – Benchmark functional units and abbreviations

Intermediate output 1 – Product & Construction Stage Carbon

- The next section to the right provides the result of multiplying the quantity inputted in Step 3, by the A1-A3, A4, A5, and overall [A1-A5] emission factors derived in Step 2.

- See Table 1 in the ‘Terminology Used’ section of this user guide for an explanation of what product & construction stage carbon [A1-A5] includes.

Product & Construction Process Stage Carbon

The table below shows the breakdown of Product & Construction stage [A1-5] capital carbon for the intervention or scheme being assessed, calculated based on the quantity entered in Step 3, and the carbon intensity selected in Step 2.
This includes Raw Material Supply [A1], Transport to Factory [A2], Manufacturing [A3], Transport to Site [A4], and Construction [A5].

Product & Construction Process Stage	Product Stage	Construction Process Stage	
TOTAL A1-A5	A1-A3	A4	A5
269.79	213.71	49.77	6.31

A NOTE ON UNCERTAINTY

This benchmark includes a mixture of footways, cycle lanes, crossings and modal filters which should reflect most use cases given the small scale nature of each benchmark. Note that reasonable assumptions will need to be made where a scheme is solely comprised of road markings as all benchmarks within this category contain varying amounts of this as well as other features. Roadside Elements benchmark (RE3) contains only signs and signposts and could be used to get an estimate for schemes only including wayfinding improvements

Figure 10 - Product & Construction Process Stage Infrastructure Carbon intermediate output

- This section also provides 'a note on uncertainty,' which draws attention to elements that are common to the category selected but not captured in benchmarks, and other considerations that should be recognised when interpreting estimated results.

Intermediate output 2 – Carbon Cost Ratio (CCR)

- The Carbon Cost Ratio (CCR) offers insight into the carbon impact per £100k of direct works cost incurred.

- The first column in this section shows the estimated direct works cost per unit (£/unit), and is determined as follows:

  - If the user opted to input direct works cost in Step 1, this is first divided by the quantity entered in Step 3 to obtain an estimate of cost per unit (£/unit).
  - If direct works cost is not input in Step 1, but the user has selected a carbon intensity lever setting that matches an embedded benchmark which includes cost per unit (£/unit) data (in the C-Background Data worksheet), then this value will be shown.
  - If neither of these conditions are met (i.e. the user does not enter a direct works cost and inputs a carbon intensity lever setting without a corresponding benchmark) then the average direct works cost for that intervention type, based on all available benchmarks, is shown.

- The second column shows the CCR, which is calculated by dividing the carbon intensity selected in Step 2 (tCO2e/unit) by the estimated direct works cost per unit (£/unit). Please refer to the Terminology section for the definition of direct works cost.

Step 4. Define Construction Stage Timeframe

- Inputting the estimated (or known) construction start and end months enables the infrastructure carbon impact to be plotted over time in the output dashboard.

- This step is required to produce the emissions over time chart on the output dashboard, and to correctly plot use stage carbon over time in Intermediate Output 3.

While the exact construction timeframe is unknown, we assume that construction will take place in early 2025 and take approximately 3 months. For this reason, Feb-25 to Apr-25 have been entered as shown in Figure 12.

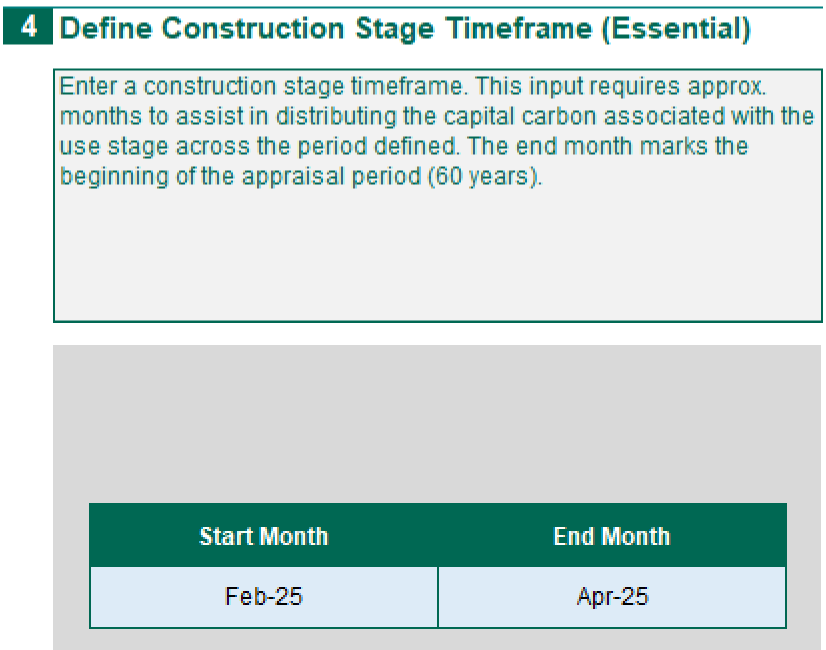


Figure 11 - Construction stage Timeframe input

Intermediate Output 3 – Use Stage Carbon

- The LTICBT is primarily focused on estimating product and construction process stage [A1-A5] carbon impacts, however the tool also provides a limited, high-level estimate of use stage [B2-B4] carbon impacts based on typical relative proportions to A1-A5 impacts.

- See Table 1 in the 'Terminology Used' section of this user guide for an explanation of what use stage carbon [B2-B4] includes.

- This section of the I-User Input worksheet provides a suggested estimate of use stage [B2-B4] emissions based on the following relative proportions:

    - Maintenance [B2] = 1% of A1-A5 emissions (in line with RICS guidance)
    - Repair [B3] = 25% of B1 emissions (in line with RICS guidance)
    - Replacement [B4] = X% of A1-A4 emissions, where X% is the average percentage of B4 emissions relative to A1-A4 emissions for the selected intervention type. This has been derived for each intervention type based on the typical number of times that key materials would require replacement over a 60-year period.

- The use stage emissions estimate is then distributed over the 60-year period following the construction stage timeframe entered in Step 4.

- Replacement [B4] impacts are typically concentrated to specific years when certain materials or components reach their 'reference service life (RSL)' and need replacement. For simplicity given each material has a unique RSL, all use stage carbon impacts are distributed linearly over 60 years.

Use Stage Carbon

The tables below show the estimated emissions of the project for use stages B2-B4. This requires no user input. The estimated use-stage emissions are spread equ

Use stage	Maintenance	Repair	Replacement					
TOTAL B2, B3 & B4	B2	B3	B4	2025	2026	2027	2028	2029
227.33	2.70	0.67	223.96	3.79	3.79	3.79	3.79	3.79

Figure 12 - Infrastructure carbon emission (tCO2) input table

- Replacement [B4] impacts are typically the most significant of use stage [B1-B7] impacts. Use [B1], refurbishment [B5], operational energy use [B6] and operational water use [B7] are not estimated in the tool. These impacts are typically less significant, but it should be noted in any reporting that these modules are excluded from use stage carbon impact estimates.

Additional Input Lines

- Other elements of a proposed intervention can be assessed using the additional input lines below the first. Alternatively, these additional lines can be used to assess several components of a larger scheme, or to compare design options for a particular intervention. Steps 1-5 can be repeated for each input row.

The first input line has been used to assess the infrastructure carbon impact of the 1.2km of corridor that can accommodate installation of a high quality, stepped cycle lane. As shown in Figure 15, the 200m section of cycle track replacing the disused rail corridor has been added into the second input line. A lever setting of 63 has been selected corresponding with the 'Cycle track (new track)' benchmark. Finally, the 100m of road that is too narrow to accommodate a cycle lane, and instead is likely to include a modal filter, has been added into the third line. This time, the 'Modal Filter' intervention type has been selected from the Active Travel category, and the carbon intensity lever is set to '10' to reflect the 'landscaped modal filter'.

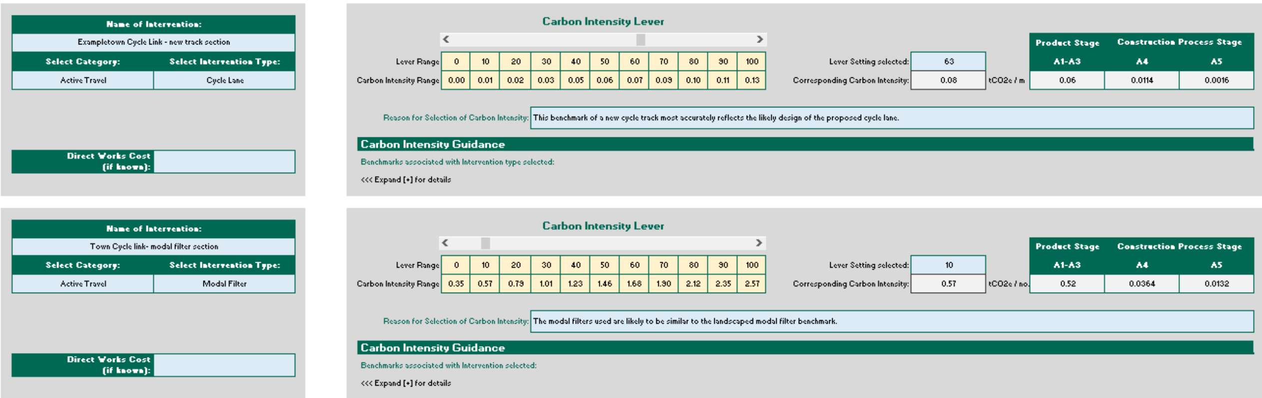


Figure 13 – Second and third input lines

3d. LTICBT Outputs

O-Summary Worksheet

- The O-Summary worksheet summarises the quantified carbon impacts in a table format. Included are:

    - A breakdown of emissions by intervention.
    - A breakdown of emissions by lifecycle stage.
    - A breakdown of emissions by category.
    - Projected annual and cumulative emissions over time.

- The layout of this worksheet is shown in Figure 16 and Figure 17. Each element of this worksheet is annotated in these figures and described in Table 1.

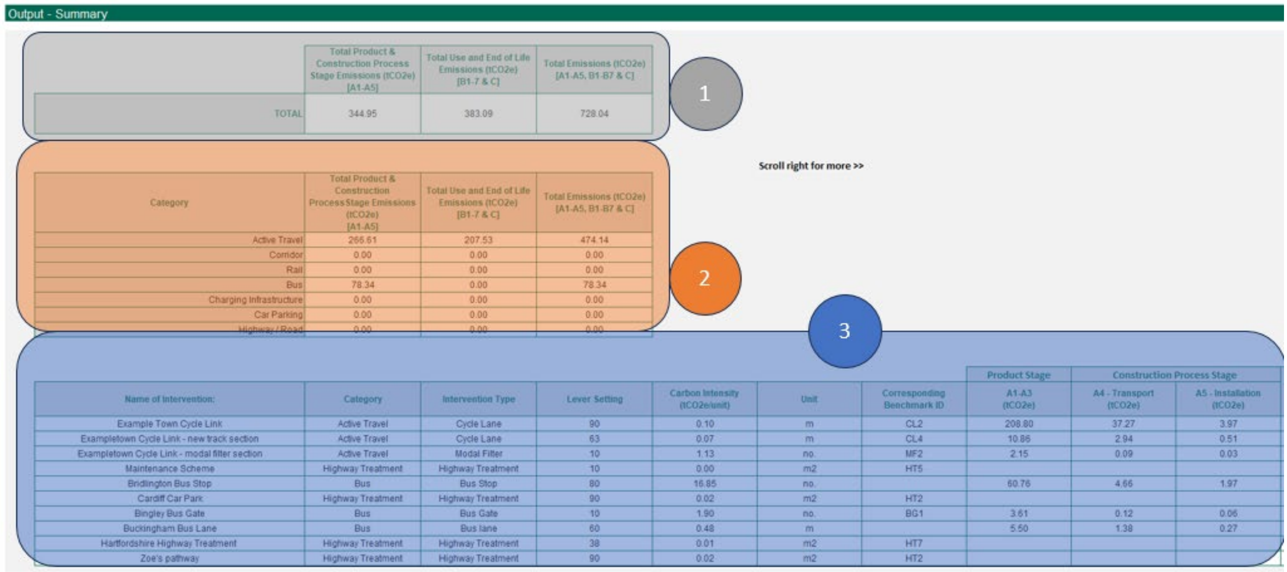


Figure 14 - Snapshot of the leftmost section of the O-Summary worksheet

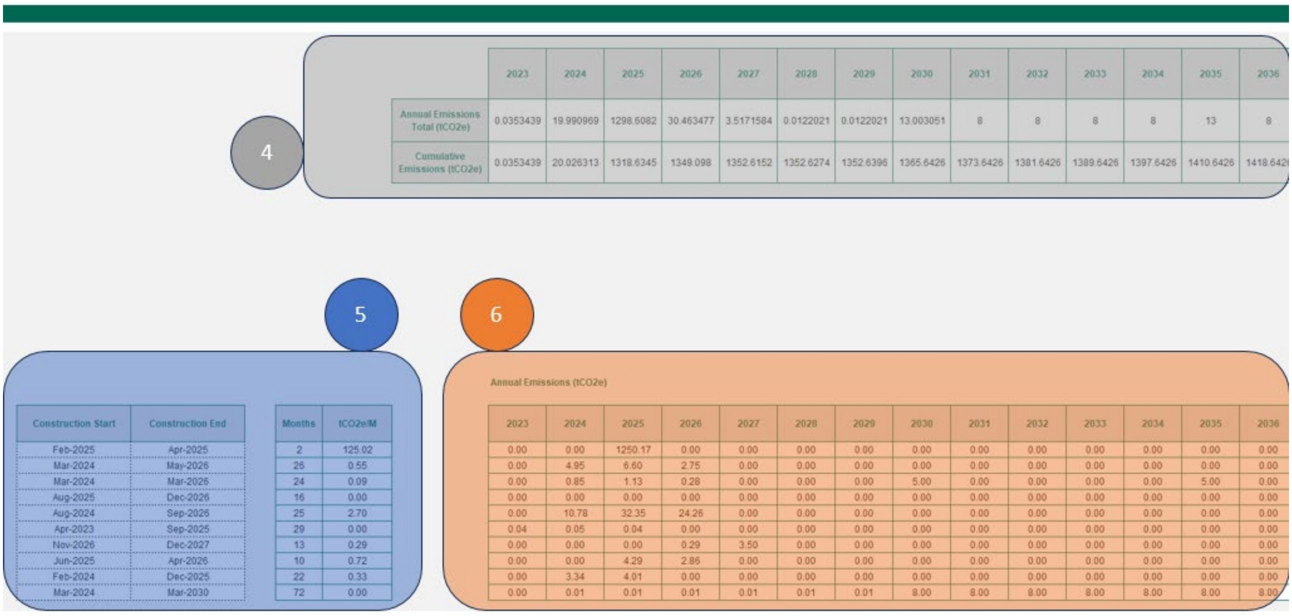


Figure 15 - Snapshot of the rightmost section of the O-Summary worksheet

Reference	Description
1	The carbon impact of all interventions assessed is provided here, broken down into product & construction process stage emissions, use and end of life stage emissions (if inputted), and total emissions.

2	The combined impact of assessed interventions is summarised by intervention category.
3	This table lists each input line populated in the I-User Input worksheet and provides a one-line summary of each intervention assessed. Information shown for each intervention assessed includes metadata such as the user-determined name for the intervention, the category of intervention, and the intervention type. The table also shows the lever setting and carbon intensity selected for the intervention, the input units, and, if the user has selected a carbon intensity that matches one of the benchmarks embedded in the LTICBT, the benchmark ID will also be shown. At the right-hand side of the table, the total calculated carbon impact for each intervention assessed is shown, as well as a breakdown by lifecycle stage. The carbon cost ratio (CCR) is also shown.
4	The annual impact of each intervention is summarised into a table showing overall annual carbon impact, as well as the cumulative impact over time. The cumulative impact spans the construction period and the subsequent appraisal period of 60 years.
5	The number of months between the user-inputted construction start and end dates is calculated and is used to split the Product & Construction Process stage carbon impact [A1-A5] across multiple years. This also defines the appraisal period for the use and end of life stage impacts.
6	In this table, the monthly product & construction process stage carbon impact of each intervention is distributed over the period defined by the construction start and end dates, and annual carbon impacts are shown. Any use and end of life stage carbon impacts inputted by the user are also distributed across the table.

Table 3 - Description of each element of the O-Summary worksheet as annotated in Figure 15 and Figure 16

O-Dashboard Worksheets

- Two dashboards are generated by the LTICBT to provide insights across a range of assessment objectives:
  - The first dashboard, O-Dashboard Comparative, facilitates the comparison of individual assessments, aiding in option identification and highlighting hotspots. This is likely to be of most use where the LTICBT has been used to assess or compare interventions or design options.
  - The second dashboard, O-Dashboard Totals, presents cumulative impacts of all assessments, providing users with an understanding of the combined impact of assessed interventions. This is likely to be of most use when evaluating the total impact of a wider programme of interventions.

O-Dashboard Comparative Worksheet

- The O-Dashboard Comparative worksheet provides a comparative summary of the quantified carbon impacts of assessed interventions. The layout of this worksheet is shown in Figure 17. Each element of this worksheet is annotated in these figures and described in Table 3.

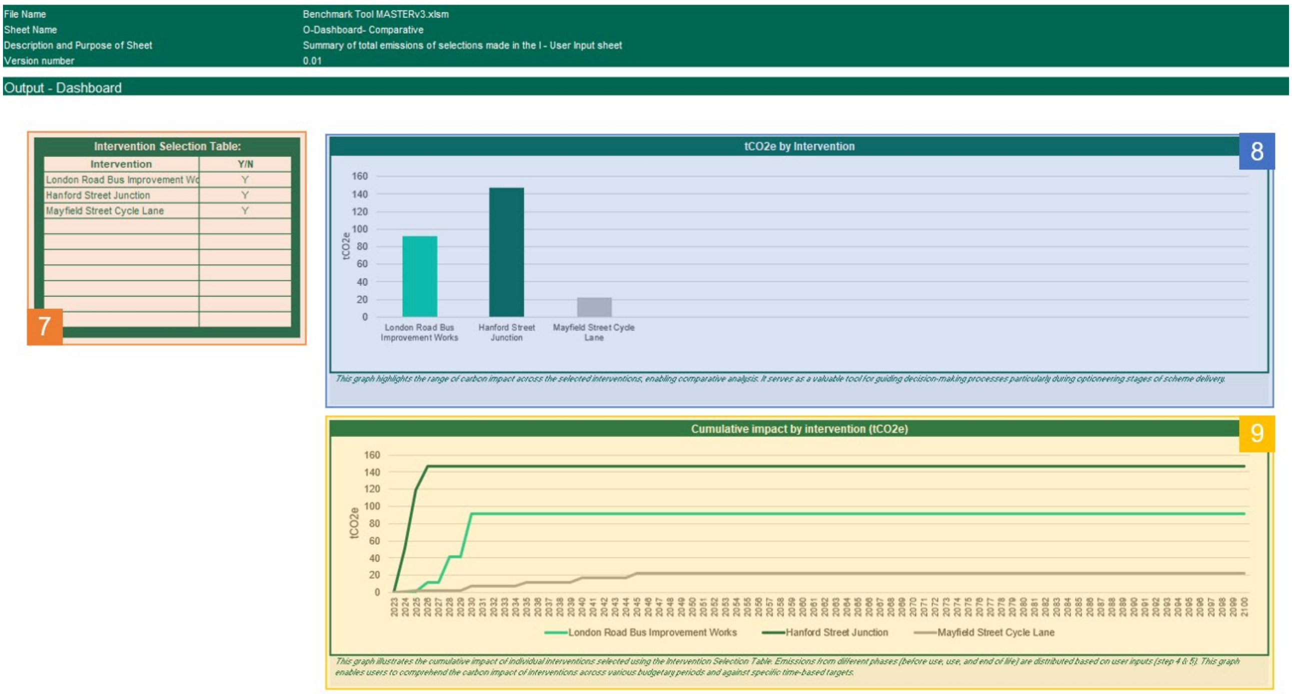


Figure 16 - Snapshot of the O-Dashboard Comparative worksheet

Reference	Description
7	Selection table allowing the user to toggle (Y/N) which interventions are included in the comparison.
8	This bar chart shows the total carbon impact by intervention.
9	In this chart, annual cumulative emissions over time are shown for each intervention assessed.

Table 4 - Guidance table for Figure 18

O-Dashboard Totals Worksheet

- The O-Dashboard Totals worksheet provides an overall total summary of the quantified carbon impacts of assessed interventions. The layout of this worksheet is shown in Figure 19. Each element of this worksheet is annotated in these figures and described in Table 3.

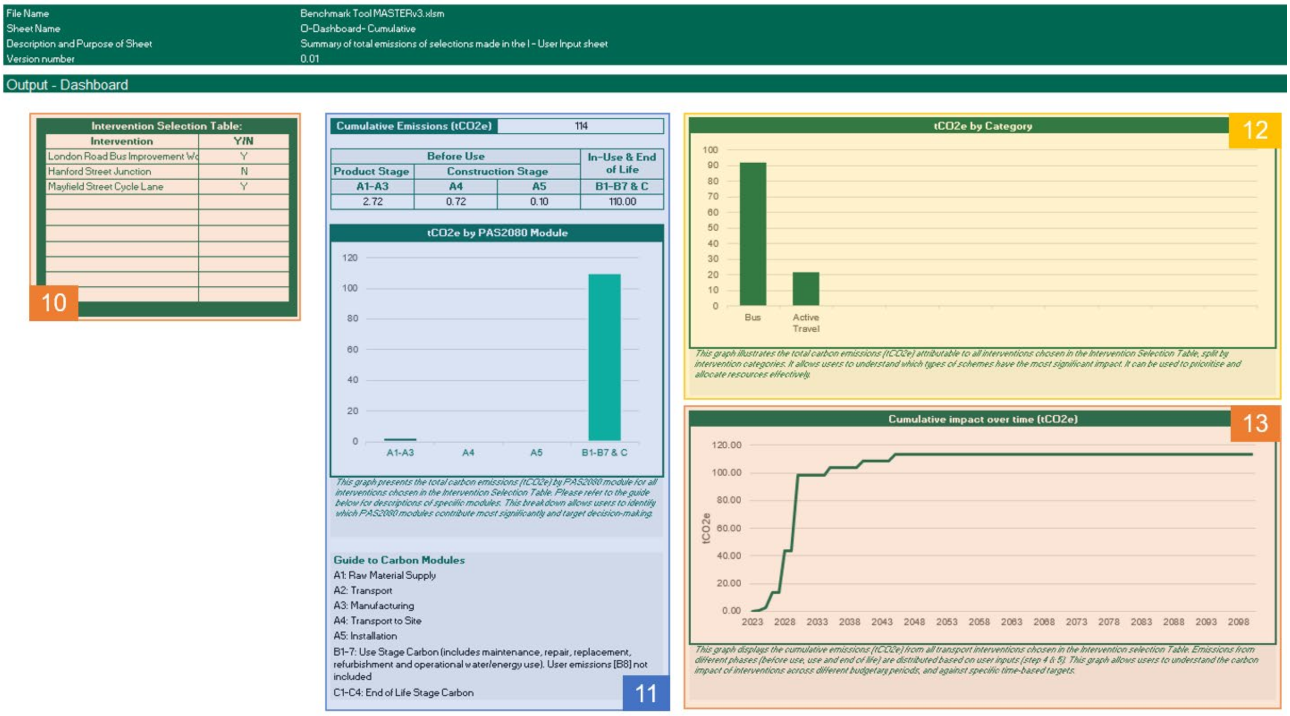


Figure 17 - Snapshot of the O-Dashboard Totals worksheet

Reference	Description
10	Selection table allowing the user to toggle (Y/N) which interventions are included in the total summary.
11	This section provides a breakdown of total estimated carbon emissions by lifecycle stage, in both tabular and graphical format.
12	This chart provides a breakdown of estimated carbon emissions by intervention category.
13	In this chart, total annual cumulative emissions over time are shown.

Table 3 - Guidance table for Figure 19

4. LTICBT Detailed Information

4a. C-Background Data Worksheet & Adding New Benchmarks

- The C-Background Data worksheet includes a table of all benchmarks embedded within the tool, alongside the intervention type to which it belongs. For each benchmark, the table also shows:

  - **Benchmark ID** – used to identify the benchmark in workbook calculations & processes.
  - **Carbon intensity lever placement –** see section 4b for details on how this is derived.
  - **Description** – this is the high-level description that appears alongside the benchmarks in the Carbon Intensity Guidance tables in the I-User Input worksheet.
  - **A1-A3, A4, A5, and A1-A5 carbon emission factors** – these allow the LTICBT to produce a breakdown of emissions by lifecycle stage.
  - **Direct works cost** – represents costs directly associated with construction or execution of a project, encompassing materials, labour, and equipment. It excludes indirect costs and overheads, which are associated with broader project management, administration, or support. It is used to calculate the Carbon Cost Ratio (CCR).

- New benchmarks can be added to the LTICBT database to expand the range of embedded benchmarks, by simply adding the relevant details to the bottom of the table in the C-Background Data worksheet. Only the yellow-shaded cells need to be populated; the carbon units, A1-A5 emission factor, and the lever placement, are all generated automatically from other inputs.

4b. Carbon Intensity Lever

- The Carbon Intensity Lever is central to the benchmarking approach employed in the LTICBT. For each intervention type, benchmarks embedded in the LTICBT are positioned on the carbon intensity lever according to their respective carbon intensity.

- The Carbon Intensity Lever spans from 0 to 100 for every intervention type. For any intervention type for which there are at least two benchmarks embedded in the LTICBT, the benchmark with the lowest carbon intensity is allocated to the lever setting of 10, and the benchmark with the highest carbon intensity is allocated to the lever setting of 90.

- Other benchmarks for a given intervention type are positioned on the Carbon Intensity Lever between these two settings, according to a linear relationship between the carbon intensities of each benchmark.

Example: The LTICBT has five benchmarks embedded for the Bus Stop intervention type. The least carbon intensive, a simple 'on road' bus stop including only the minimum permissible provision of infrastructure, has a carbon intensity of 8.75 tCO2e / no., and is allocated the lever setting of 10. The most carbon intensive, a 'bus bay' which includes construction of a pull-in bay, has a carbon intensity of 18.01 tCO2e / no., and is allocated the lever setting of 90. Another benchmark is provided for a bus stop with construction of a full-width bus boarder, which has a carbon intensity of 10.83 tCO2e / no. This is closer in carbon intensity to the 'on road' bus stop, and correspondingly is allocated the lever setting of 28.

- The provision of the Carbon Intensity Lever allows the user to select a lever setting that falls between benchmarks, rather than being restricted to carbon intensities of given benchmarks. This allows the flexibility to reflect interventions which may fall between benchmarks in terms of their carbon intensity, as shown in the example below.

Example: The user wishes to estimate the impact of constructing a new prestressed concrete beam road bridge, approximately 20m wide. The LTICBT has four benchmarks embedded for this intervention type, two of which are for prestressed concrete beam bridges. One is for a 15m-wide bridge, and is allocated the lever setting of 10, and the other, a 30m-wide example, is allocated the lever setting of 47. It would therefore be appropriate to select a lever placement between 10 and 47 but closer to 10, i.e. approximately 22.

- Lever settings 0-9 and 91-100 enable the user to select a carbon intensity above or below the benchmarks associated with an intervention. This allows the user to select a lever setting that is lower than the least carbon intensive benchmark, or higher than the most carbon intensive, as these benchmarks are allocated the lever settings of 10 and 90 respectively.

- To prevent selection of carbon intensities that are unrealistic for a given intervention, the settings 0-9 and 91-100 extrapolate the same linear relationship between lever setting and carbon intensity that is established between settings 10 and 90, i.e. the difference in carbon intensity between settings 0 and 10 is equal to the difference in carbon intensity between settings 10 and 20.

- Also to prevent selection of unrealistic carbon intensities, the user cannot select lever settings below 0 or above 100. If the user believes the intervention they are testing is substantially more carbon intensive than the most carbon intensive benchmark in the tool for the given intervention type, it may be advisable to apply additional uplift, or contact DfT for further advice.

Example: The user wishes to estimate the impact of constructing a new junction, however the benchmark with the highest carbon intensity does not include consideration of extensive landscaping that would be required in uneven terrain environment. As such, the user selects the lever setting of 100.

- The allocation of lever settings for benchmarks is responsive to new benchmarks being added for a particular intervention type (Section 4a), i.e., when adding a new benchmark that has a carbon intensity higher than any other benchmarks for the intervention type, the lever setting of 90 will be reallocated to this new benchmark, and the span of carbon intensities between settings 10 and 90 will widen, resulting in other benchmarks being assigned new lever settings corresponding to their new position.

- For this reason, the lever settings of different interventions should not be used to compare the carbon impact of interventions. The corresponding carbon intensity is the indicator of carbon impact.

- When two benchmarks categorised under the same intervention type share the same lever placement, their carbon intensities may in fact be slightly different. To ensure consistency, the highest carbon intensity among the corresponding benchmarks will be used for the assessment. For example, CL3 & CL4 share the same lever placement (i.e 64). The corresponding carbon intensity is taken from CL4 since the A1-A5 carbon intensity (tCO2e/m) is higher (0.0738) than CL3 (0.0734).

4c. Highway Treatment Interventions

- While the LTICBT is primarily designed to estimate product and construction process stage carbon impact, the inclusion of eight highway treatment benchmarks within the tool enables limited ability to use the benchmarking process to assess use stage impacts of road-type interventions.

- For ease and to simplify usability of the tool, the user input process for highway treatment benchmarks is much the same for other intervention type. The outputs of an assessment using these benchmarks, however, are calculated in a different manner. This difference arises as highway treatment activities (such as preservation, surface dressing, and resurfacing) are typically considered to be use stage activities when undertaking a carbon assessment and are to be included in carbon modules B1-B5 in accordance with PAS2080, or as ‘operational carbon’ in line with TAG Unit A3. The following paragraphs provide details of the calculation process for scheme assessments of highway treatment interventions.

- Figure 20 shows how selecting the category Highway Treatment alters the input section for the input row. Notably, references to product and construction stage emission factors are replaced with use stage emission factors, and the resultant output in the following section is assigned to ‘use stage’. Input section 5, which usually allows users to input use and end of life emissions, is modified to only accept end of life emissions.

- In input section 4, 'Define the construction stage timeframe,' populate construction start and end months with the period over which the highway treatment will be conducted.

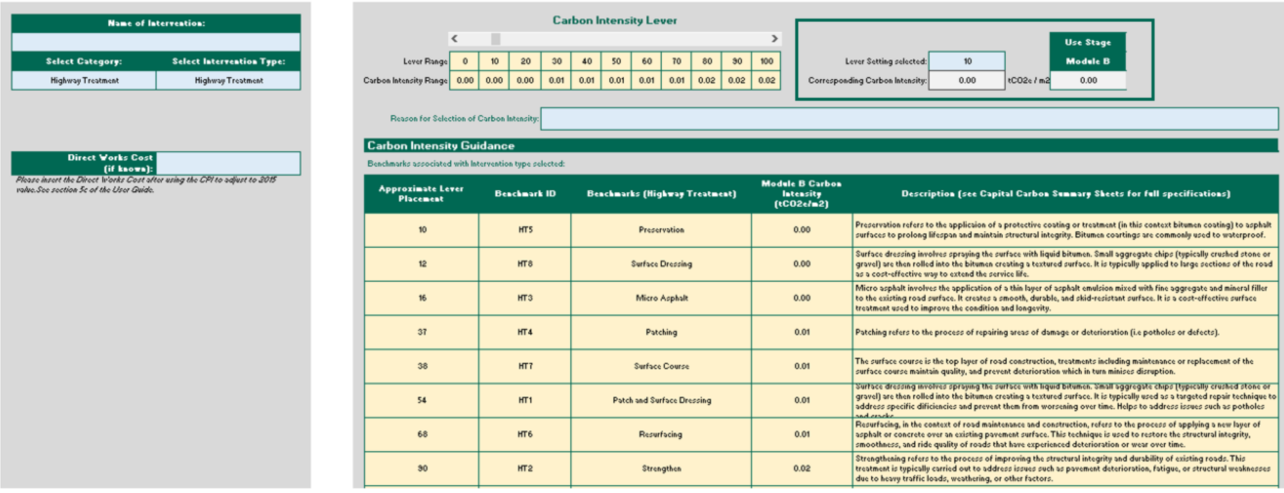


Figure 18 – Input sections with highway treatment intervention type selected. Note the 'use stage' cell at top right replaces the usual 'product stage' and 'construction process stage' cells.

- In the O-Summary tab, emissions associated with highway treatment interventions are classified under 'Total Use and End of Life Emissions [B1-7 & C]' to ensure accurate reporting in the correct lifecycle stage. This is also reflected in the O-Dashboard Comparative and O-Dashboard Totals worksheets.

- To allow the flexibility to use these benchmarks regardless of road type, highway treatment benchmarks are provided in units of tCO2e/m2, in contrast to the tCO2e/m units used for road benchmarks.

4d. Inputting Direct Works Cost

- If the direct works cost of a proposed intervention is known, it is recommended to input this in the optional 'Direct Works Cost' cell in the leftmost input section of the I-User Input tab, as described in section 3b (Step 1). To accurately estimate installation process stage [A5] emissions, it is important that the direct works cost inputted has been deflated to a 2015 value.

- To deflate costs of new schemes to 2015 value using the Consumer Price Index (CPI), the following steps should be used:

  - Determine the current year for which you have cost data.
  - Find the CPI value for the current year and the base year (2015) from reliable sources such as the Office for National Statistics.
  - Calculate the change in CPI by dividing the CPI of the base year (2015) by the CPI of the current year.
  - Divide the cost in the current year by the CPI ratio to obtain the equivalent cost in 2015 value:

Deflated Cost in 2015 = Cost in Current Year / CPI Ratio

- Alternatively, an online inflation calculator can be used, however, it should be ensured that it is hosted by a reputable source such as the Bank of England.

4e. Schemes Consisting of Multiple Intervention Types

- When using the LTICBT to assess the impact of an intervention or scheme consisting of several intervention types, several input lines can be used to assess the impact of each component individually.

- It is anticipated that mobility hubs may be a common example of when this approach may be used. Mobility hubs typically comprise a range of interventions, such as cycle parking, docking stations, bus stops, crossings, EV charging facilities, and park and ride facilities. To provide flexibility given the many possible combinations of these components, the carbon impact of mobility hubs can be assessed by inputting the components individually.

- The total impact of all components can then be obtained from the O-Dashboard Totals worksheet, by selecting the relevant interventions from the intervention selection table.

5. Limitations

5a. Scope

- The output of assessments undertaken with the LTICBT comprise part of a whole life carbon assessment. In particular, the tool does not support estimation of user carbon impacts of interventions. Results should not be considered as a whole life carbon assessment in isolation of other assessments that account for user carbon.

- Care should be taken when comparing the carbon impacts of intervention types without contextualisation of the wider impacts of implementation. Interventions with a high infrastructure carbon impact may, for example, induce a significant modal shift, resulting in a reduction in user emissions, thus resulting in a net-reduction in carbon over the whole lifecycle, or a lower whole life carbon impact than an intervention with a low infrastructure carbon impact.

- The LTICBT is primarily focused on estimating product and construction process stage [A1-A5] carbon impacts, however the tool also provides a limited, high-level estimate of use stage [B2-B4] carbon impacts based on typical relative proportions to A1-A5 impacts.

- The outputs of the tool include estimates of carbon impacts from all product & construction process lifecycle stages, namely from raw material supply [A1], transport [A2], manufacturing [A3] of products, and transport [A4] and installation process [A5] of construction. The outputs of the tool also include estimates of some use stage carbon impacts, namely maintenance [B2], repair [B3] and replacement [B4].

- The tool does not provide an estimate of carbon impacts pertaining to other modules, including pre-construction [A0], use [B1], refurbishment [B5], operational energy use [B6], operational water use [B7], or end of life stage [C1-C4] impacts. As the LTICBT is designed for use at the earliest stages of scheme development, in most cases it will not be proportionate to estimate carbon impacts relating to these modules, and it is acceptable for these to be excluded from assessment.

- Most notably, however, the tool does not provide an estimate of user carbon impacts [B8], which should be accounted for as part of a whole life carbon assessment regardless of the scheme development stage as these impacts are likely to be significant.

- More detail regarding the development of benchmarks embedded in the LTICBT is provided in Annex B.

5b. Accuracy

- The top-down benchmarking approach utilised by the LTICBT provides a high-level estimate of carbon impact. This is considered proportionate for assessments of interventions typically featured in LTPs, and for assessments of proposed schemes at the earliest stages of development, given the need to assess carbon impact in the absence of detailed design information.

- The accuracy of the outputs of the LTICBT is reliant on ability of users to appropriately compare the intervention being assessed against the benchmarks embedded in the tool.

5c. Limitations of the Construction – Installation Process [A5] Methodology

- As described in Annex B, section B4, a cost-based method has been used to calculate carbon emissions pertaining to the construction – installation process module [A5]. In the context of early project delivery stages, the use of a cost-based method is considered proportionate given the limited availability of detailed construction information, however, this does not reflect the variability in construction methods and/or processes across different schemes, such as the use of low or zero-emission construction equipment.

- Moreover, the accuracy of the cost-based method is heavily influenced by the accuracy of the cost estimates, however as installation process emissions are typically less than 10% of total product & construction process stage [A1-5] emissions, this is considered relatively negligible at the level of detail required at early-stage assessments.

- It is reasonable to assume that estimated construction emissions [A5] for benchmarks developed using the case study approach may be more accurate, as their direct work costs reflect the realities of real schemes.

- The accuracy of installation process emissions [A5] is influenced by user-input Direct Works Cost (adjusted to 2015 values) entered in the ‘I-User Input’ tab under ‘Select Intervention Type’. Entering inaccurate costs has the potential to distort estimates of construction emissions [A5], and users should be prudent to avoid inclusion of costs that do not fall under the scope of ‘direct works costs’, such as contingencies and allowances. To avoid underestimating construction emissions [A5] it is recommended that the direct work costs entered in the ‘I-User Input’ tab should not be lower than the default estimate provided in embedded benchmarks.

6. FAQs

- Answers to anticipated frequently asked questions are provided in Table .

Question	Answer
Why can't I see the Carbon Intensity Guidance table?	For simplicity, the Carbon Intensity Table in each input line is collapsed by default. It can be made visible by expanding the 'grouped' rows in each input line, which is done by clicking on the '+' symbol on the far left, in line with the '<<< Expand for details' text. Alternatively, the Carbon Intensity Tables for all input lines can be expanded at once by clicking on the '2' at the top left of the spreadsheet, in line with the row and column numbers. The tables can be minimised by using the '-' or '1' buttons.
Why can't I edit the cell?	Only cells shaded blue can be edited. All other cells are for information or calculation only.
Why is the use stage input period set to 60 years?	In accordance with principles outlined in EN 15978, a Reference Study Period (RSP) of 60 years has been chosen for the whole life carbon assessments. A service life of 60 years is broadly representative of different asset types and is a sufficient period of time for an asset to undergo maintenance, repair and/or replacement.

Table 5 - Frequently asked questions and answers

Annex A

Infrastructure Carbon Summary Sheets

Annex B

Benchmark Development Methodology

B1. Overview of approach

- Most benchmarks embedded in the LTICBT have been developed according to one of two primary methodologies: the ‘design standards & guidance approach’ (Section B2), or the ‘case study approach’ (Section B3). These methods both involve the development of a Bill of Quantities (BoQ) which is then used as the basis of a carbon assessment (Section B4).

- Some benchmarks have been developed using bespoke methodologies, as necessitated by best practice and intervention-specific requirements, as described in Section B6.

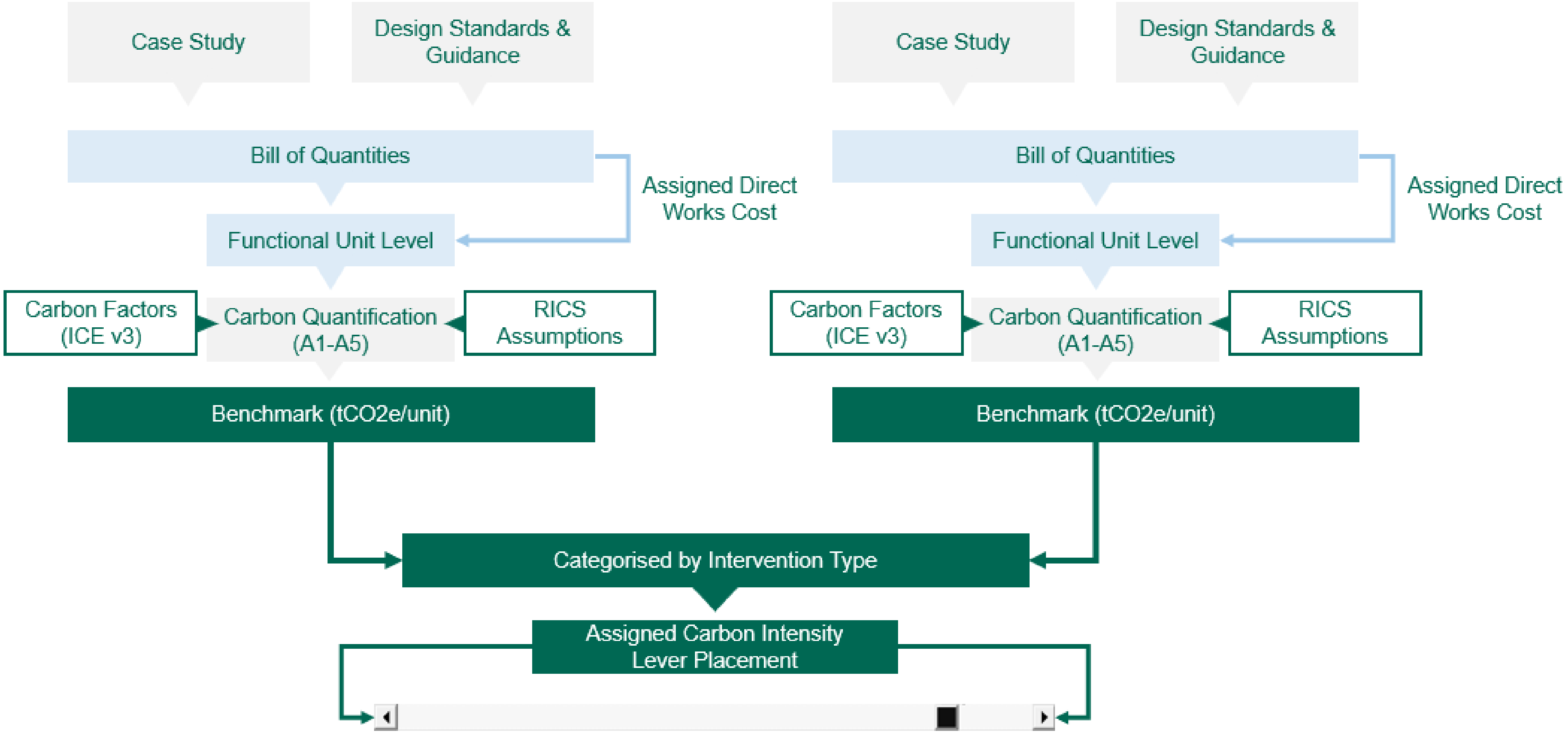


Figure 20 – Outline of the process of how benchmarks were developed and then incorporated into the LTICBT

- A full list of benchmarks and their development methodology is provided in Table 6.

Intervention Category	Intervention type	Benchmarks	Methodology used
Active Travel	Footway	• New Footway (min width) • New Shared Use Footway • Local Street Footway • Primary Road Footway	Design Standards & Guidance Approach – see Section B2
Active Travel	Cycle Lane	• Light Segregated • Stepped Cycle Track • Fully Kerbed Cycle Track • Cycle Track (new track)	Design Standards & Guidance Approach – see Section B2
Corridor	Travel Corridor	• Active Travel Provision (along approx. 85-100% of corridor length) • Active Travel Provision (along approx. 85-100% of corridor length) + Bus Provision (along approx. 3% of corridor length) • Active Travel Provision (along approx. 45-60% of corridor length) + Bus Provision (along approx. 25-50% of corridor length) • Active Travel Provision (along approx. 10-15% of corridor length) + Bus Provision (along approx. 10-15% of corridor length)	Case Study Approach – see Section B3
Active Travel	Pedestrian/Cycle Crossing	• Zebra Crossing • Puffin Crossing • Toucan Crossing • Refuge Island	Design Standards & Guidance Approach – see Section B2
Active Travel	Pedestrian/ Cycle Bridge	• Single Span Pedestrian/Cycle Steel Truss Bridge (5m wide) • Multiple Span Pedestrian/Cycle Steel Truss Bridge (4m wide)	Bespoke methodology – see Section B6
Active Travel	Pedestrian/ Cycle Subway	• Pedestrian/Cycle Subway (5m wide) • Pedestrian/ Cycle Subway (25m wide) • Pedestrian/Cycle Subway (5m wide), incl. approach ramps	Bespoke methodology – see Section B6
Active Travel	Cycle Parking & Docking	• Bike Parking Loop • Bike/Scooter Docking Station	Bespoke methodology – see Section B6

Active Travel	Modal Filter	• Basic Modal Filter-Bollards • Landscaped Modal Filter • Chicane Modal Filter	Design Standards & Guidance Approach – see Section B2
Rail	Railway Station	• Railway Station Improvement • New Railway Station	Bespoke methodology – see Section B6
Bus	Bus Lane	• Reallocation to Bus Lane • Widening to Bus Lane • Partial Widening to Bus Lane	Design Standards & Guidance Approach – see Section B2
Bus	Bus Gate	• Minimal Bus Gate • Physically Separated Bus Gate	Design Standards & Guidance Approach – see Section B2
Bus	Bus Stop	• On-road • Half-Width Bus Boarder • Full Width Bus Boarder • Bus Stop Bypass • Bus Bay	Design Standards & Guidance Approach – see Section B2
Bus	Bus Station	• Refurbished Bus Station With Building • New Bus Station Without Building	Bespoke methodology – see Section B6
Charging Infrastructure	Charging Infrastructure	• Smart DC Charger C7 • Urban Highway Charging Terminal • E-Bike Charging Dock	Bespoke methodology – see Section B6
Car Parking	Car Parking	• Car Parking Resurfacing • Car Parking Full Construction	Design Standards & Guidance Approach – see Section B2
Highway/Road	Road	• Local Street • Major Road	Design Standards & Guidance Approach – see Section B2
Highway/Road	Junction	• Local Street Junction • Major Road Junction • CYCLOPS Junction • Major MRN Junction (Case Study)	Design Standards & Guidance Approach – see Section B2 and Bespoke methodology – see Section B6
Highway/Road	Road Bridge	• Prestressed Concrete Beam Bridge (15m wide) • Steel-Concrete Composite Bridge (15m wide) • Prestressed Concrete Beam Bridge (30m wide) • Steel-Concrete Composite Bridge (32m wide)	Bespoke methodology – see Section B6
Highway Treatment	Highway Treatment	• Patch Surface Dressing • Strengthen • Micro Asphalt • Patching • Preservation	Bespoke methodology – see Section B6

		• Resurfacing • Surface Course • Surface Dressing	
Highway/Road	Carriageway	• Local Street Carriageway • Primary Road Carriageway	Design Standards & Guidance Approach – see Section B2
Highway/Road	Roadside Elements	• Local Street Elements • Primary Road Elements • Traffic Signs	Design Standards & Guidance Approach – see Section B2
Highway/Road	Highway	• New 7-8m wide single carriageway road with significant bridge structure accounting for approx. 10-15% of the scheme length • New dual carriageway road, each carriageway 7-8m wide (total width approx. 15m)	Design Standards & Guidance Approach – see Section B2

Table 6 - Methodologies used to create benchmarks

B2. Design Standards & Guidance Approach

- The design standard & guidance approach was used to develop benchmarks for intervention types for which clear ‘subtypes’ exist. An example of a subtype intervention type is cycle lanes – there are distinct designs for cycle lanes, ranging from simple lane marking to a full reconfiguration of road space. Each distinct design (subtype) has its own carbon intensity.

- For these intervention types, design standards, guidelines, and/or typical specifications have been studied to establish the most common designs for each intervention type. These documents have then been used as reference materials from which hypothetical Bills of Quantities (BoQ) have been developed for each ‘subtype’.

- Material quantities and attributes from these BoQs have then been multiplied by appropriate carbon factors to produce a carbon impact – this process is described in more detail in Section B4.

B3. Case study Approach

- The case study approach was used to develop benchmarks for intervention types for which there is a continuous range of possible designs, and/or which typically vary considerably from design standards. An example of a case study intervention type is a railway station.

- To reflect the range of possible carbon intensities, BoQs from real-world examples of these intervention types have been used to develop these benchmarks.

- Once appropriate BoQs have been identified, these benchmarks have been developed in the same way as a subtype method, by multiplying material quantities by appropriate carbon factors, as described in Section B4.

- Benchmarks based on real-world case studies are described in the LTICBT with key characteristics such as scale, material, and design, but without identifying the scheme.

B4. Carbon assessment of BoQs

Overview

- Regardless of the approach used to develop a BoQ for an intervention, the same methodology is used to quantify product and construction process stage carbon emissions [A1-A5].

Product Stage [A1-A3]

- The use of BoQs is the preferred approach for quantifying product stage carbon [A1-A3]. In accordance with EN 15978, all items listed in BoQs are assigned appropriate carbon factors.

  Material Quantity x Material Carbon Factor

- To ensure consistency and comparability across benchmarks, carbon factors from the Inventory of Carbon and Energy (ICE) V3 database have been used wherever possible. Consistent use of carbon factors also enhances transparency in the assessment process.

- In subsequent project phases, it is advisable to use these carbon factors to quantify carbon savings and report progress until detailed, product-specific information is available. Once these conditions are fulfilled, it might be appropriate to use carbon factors derived from environmental product declarations (EPDs), particularly if they have undergone independent verification according to ISO 14025. This serves to prevent discrepancies in product stage carbon impacts arising due to subjective selection of carbon factors.

Construction Process Stage (Transport) [A4]

- Transport impacts [A4] associated with trips from the manufacturing plant to the project site have been calculated using the formula below.

  Material (or product) mass (found in BoQ) x transport distance x carbon conversion factor for outwards & return trip.

- For consistency, RICS 2023 transport scenarios for UK based projects (shown in Table 6) have been used. Materials/products were categorised into locally, regionally, European, and globally manufactured.

Scenario	Assumed Distance Travelled (km)
Locally Manufactured (e.g. concrete, aggregate, earth)	20

Locally Manufactured (general) (e.g. aggregate, earth)	50
Regionally Manufactured (e.g. plasterboard, blockwork, insulation, carpet, glass)	80
Nationally Manufactured (e.g. structural timber, structural steelwork, reinforcement)	120
European Manufactured (e.g. CLT, façade modules, carpets)	1500
Globally Manufactured (e.g. specialist stone cladding)	500

Table 7 – RICS 2023 transport scenarios and assumed distance travelled

- Suitable carbon conversion factors have been sourced from the BEIS UK Government (2022) (tonnes per km) for the average laden rigid HGV have been used to quantify the impact of outward journeys and carbon factors based on 0% laden have been used to quantify the impact of return journeys.

Construction Process Stage (Construction - Installation Process) [A5]

- Costs have been assigned to individual materials within the BoQs to calculate a cumulative cost for each benchmark. These costs have been adjusted to 2015 values, enabling construction emissions [A5] to be quantified using the figure of 1.4tCOe/£100k (which is based on the March 2015 value of £100k), sourced from RICS Whole Life Carbon Assessment for the Built Environment (2017).

- For benchmarks developed using the case study approach (section B3), estimated costs (adjusted to 2015 values) from previous schemes, factored down per functional unit (i.e tCO2e/m, tCO2e/no.), have been used to quantify construction emissions [A5] using the same RICS figure. As an example, consider a previous bridge scheme covering a span of 10m with an estimated direct works cost of £20m (adjusted to 2015). The total construction emissions for this scheme amount to 280 tCO2e, resulting in 28 tCO2e per metre.

- Using both approaches, construction emissions [A5] can be estimated per functional unit for benchmarks created using design standards and guidance or a case study. The user is required to input a quantity, enabling the scaling of construction emissions [A5] to specific schemes. In cases where the user selects a carbon intensity not associated with a specific benchmark, the average construction emissions [A5] for an intervention type, per functional unit is used.

- Should the user have a more accurate estimate of the intervention's cost, they have the option to input a Direct Works Cost in the 'I-User Input' tab under 'Select Intervention Type'. This cost is then used to estimate construction emissions [A5], replacing the methods above. Construction emissions [A5] are further disaggregated to a unit-level upon the entry of a corresponding quantity.

B5. Data sources

- Table 4 summarises all data sources utilised as part of the benchmark development methodology.

Data source	Use
Inventory of Carbon and Energy (ICE) V3 database	Carbon Factors used to quantify product stage emissions [A1-A3]
RICS Transport Scenarios (2023)	Transport distances used to quantify transport emissions [A4].
BEIS UK Government (2022) Carbon Conversion Factors (tonnes per km)	Average laden rigid HGV carbon conversion factors have been used to quantify the impact of outward journeys and carbon factors based on 0% laden have been used to quantify the impact of return journeys [A4].
RICS (2017)	Construction & Installation cost-based benchmark (1.4tCO2e/£100k scheme cost).

Table 8 - Data sources used in benchmark development

B6. Bespoke methodologies

- Some benchmarks have been developed using bespoke methodologies, as necessitated by best practice and intervention-specific requirements. These are outlined below:

Bridge & subway benchmarks

- Benchmarks for Pedestrian/Cycle Bridges (2x), Pedestrian/Cycle Subway (3x), and Road Bridge benchmarks (4x), are based on the carbon assessments of real-world examples of these structures.
- These carbon assessments have been assessed using the PAS2080-aligned WSP Bridges Carbon Calculator, in line with the methodology set out in the Institution of Structural Engineers (IStructE) publication 'How to Calculate Embodied Carbon'.
- The assessments capture product and construction process stage carbon [A1-A5], and utilise a combination of:
    - Material quantities derived from structure designs / BoQs
    - Embodied carbon factors from the ICE Database
    - Supplier data where available
- As with benchmarks developed under the case study method (Section 5c), bridge and subway benchmarks are described in the LTICBT with key characteristics such as scale, material, and design, but without identifying the schemes.

Highway treatment benchmarks

- Highway treatment benchmarks (see Section 4c) have been developed according to a hybrid of both the standard design and case study method. BoQs have been developed for eight 'subtypes' of highway treatment (e.g., resurfacing, patching, etc.) using carbon assessments of past schemes that have included these activities.

- Each benchmark was developed using a bottom-up approach, using the same method as described in Section B4.

Charging infrastructure benchmarks

- The emission factors behind the benchmark titled 'Smart DC Charger C7' are based on the values in Table 11 of the XCHARGE Smart DC Charger C7 Environmental Product Declaration (EPD), available at NEPD-5577-4876_Charging-station--Smart-DC-Charger-C7-.pdf (epd-norge.no).
- The emission factors used for the benchmark titled 'E-bike Charging Dock' are derived by way of scaling down the Smart DC Charger C7 benchmark factors to half of their value, approximating a smaller device.

Cycle parking & docking benchmarks

- The cycle parking & docking benchmarks have been developed in line with the Design Standards and Guidance Approach outlined in Section B2, however, product information and material assumptions have been used in place of design standards.

Railway station benchmarks

- One rail station benchmark was developed according to the case study approach, with some alterations to produce a benchmark reflective of a 'do minimum' railway station upgrade/refurbishment. Alterations include removal of non-essential items, and adding items that are typical in station upgrades but were not featured in the case study used.
- To approximate an appropriate carbon intensity lever range in the absence of any further appropriate case studies, a 'do maximum' (new station) benchmark has been inputted in the tool, which has been informed by a recent carbon assessment undertaken by another company and obtained by WSP.

Bus station benchmarks

- One bus station benchmark was developed according to the case study approach.

To approximate an appropriate carbon intensity lever range in the absence of any further appropriate case studies, a 'do minimum' (minimum provision) benchmark has been inputted in the tool, developed according to the design standards & guidance approach.