Centre of Excellence
for Decarbonising Roads

WINTERPAVE LIVE TRIAL EVALUATION REPORT

Live Labs 2 North Campus

Abstract

This report evaluates a live trial conducted as part of the Live Labs 2 project, assessing the effectiveness of WinterPave, an anti-freeze additive for bituminous mixes, in reducing carbon emissions through preventing gritting cycles in winter months. The results indicate

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STATUS/AMENDMENT	PREPARED	REVIEWED	APPROVED
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Executive Summary

This report evaluates a live trial conducted as part of the Live Labs 2 project, which aims to test innovative highway solutions to improve road performance, reduce maintenance needs, and enhance safety. This trial focused on WinterPave, described by the manufactured as an asphalt additive which introduced anti-freeze characteristics to the pavement surface.

WinterPave is an anti-freeze additive which is added to an asphalt pavement mixture during the construction stage, forming an anti-icing asphalt pavement surface when laid and cured. The in-situ anti-icing asphalt surface can then effectively prevent or weaken the adhesion between ice with the road surface and prevent the formation of black ice, reducing the need for traditional salt and thus lowering carbon emissions associated with winter maintenance. For the purpose of this trial WinterPave contributed to 4.2% of the overall asphalt mix, mixes may differ depending on the site and asphalt mix.

WinterPave asphalt is claimed to contribute to carbon savings through several factors. By incorporating the additive into the asphalt mix, it is claimed that the pavement acquires anti-icing properties that reduce the requirement of de-icing salt applied during winter months. This avoidance has potential to remove the embodied carbon associated with salt manufacturing (i.e. extraction, processing, packaging), plus the upstream emissions from transporting salt to depots and sites, and the energy and materials used for storage and handling. It also has potential to eliminate downstream supply-chain impacts such as repeated bulk deliveries, depot restocking trips and the fuel consumed by gritting vehicles during application, all of which contribute to scope one and scope three emissions. WinterPave also has potential to lower operational disruptions and with faster snow/ice clearance reducing delays and idling for road users and maintenance crews, minimising traffic emissions. Furthermore, WinterPave holds potential to extend pavement life as it reduces the need for reactive repairs caused by winter-weather related damage, extending embodied emissions over a longer service life.

This trial's scope and methods have been designed to measure performance and construction emissions. The evaluation does not encompass full lifecycle or end-of-life pathways, the limited number of sites and samples reduce statistical representativeness across different conditions, and no independent, standards-based verification or multi-year monitoring protocol was included.

This report assesses carbon emissions across cradle to construction lifecycle stages in accordance with EN 15804, covering product stages A1-A3 of this standard (raw material extraction, transportation to processing facilities and manufacturing) and construction stages A4 to A5 (transportation of the finished material to site and installation). EN 15804 classifies carbon and establishes a modular, transparent approach to lifecycle assessment that assigns emissions to defined stages. Using EN 15804 ensures that this live trial is in line with the recognised European standard, follows accepted boundaries and allocation rules, and enables results that are comparable, auditable and consistent across products and projects.

Iterchimica holds a third-party verified Environmental Product Declaration (EPD) for WinterPave, obtained in 2022 and revised in 2024. The presence of a third-party verified A1-A3 lifecycle stage emissions calculation and an independently verified EPD increases confidence in the reported embodied carbon inputs and enables reliable benchmarking across Local Authorities. WinterPave's EPD reports the embodied emission factor (A1-A3) to be 0.569 $kgCO_2e/kg$.

The findings from the trial have confirmed that Winterpave contributes to reduced carbon emissions, with results showing a maximum reduction of 14% A1-A5 carbon emissions. The primary driver of carbon savings can be attributed to the elimination of gritting required on footways laid with the de-icing additive. However, this evaluation highlights the requirement to conduct further long-term trials into the performance of WinterPave over several winters to evaluate its durability and service life.

Introduction

This Evaluation Report provides a high-level assessment of WinterPave as an anti-freeze additive for asphalt pavements, an emerging sustainable material in highways, construction and maintenance, focusing on its environmental impact, product viability, and alignment with future infrastructure durability needs.

This product is being trialled as part of Live Labs 2, a three-year UK-wide programme funded by the Department of Transport (DfT), followed by a five-year monitoring and evaluation period. The programme focusses on decarbonising local highways infrastructure and assets. As part of this initiative, North Lanarkshire Council (NLC) are working alongside Transport for the West Midlands (TfWM), to establish the UK Centre of Excellence for Materials Decarbonisation in Local Roads.

The Centre of Excellence will act as a central hub for Live Labs 2, supporting research, innovation, and best practices to accelerate low-carbon solutions in road construction and maintenance. By acting as a repository of findings from Live Labs 2 trials, the Centre will drive sustainable advancements, enabling Local Authority Highway sectors across the UK to adopt more efficient and environmentally responsible materials and methodologies.

The purpose of these reports is to present key findings from a comprehensive evaluation of sustainable materials, including their carbon intensity, potential application, and overall benefits by examining carbon appraisals, lifecycle benchmarks, and various factors such as scalability, compliance, durability and supply chain viability. The aim is to provide decision-makers with valuable insights into the material's capacity to meet sustainability goals while maintaining construction quality and durability. The evaluation will inform ongoing efforts to balance environmental considerations with construction and operational efficiency in infrastructure development.

WinterPave is manufactured by Iterchimica, the product supplier and developer of the anti-icing additive used within this trial. For the North Lanarkshire Council trial, the additive was incorporated into the asphalt mixture during the manufacturing process by Holcim, the contracted asphalt producer responsible for sourcing constituent materials and producing the asphalt mix. The completed asphalt mixture was then transported to site and installed by the appointed construction contractor in accordance with the trial specification. Carbon data used within this evaluation has therefore been sourced from multiple parties, including Iterchimica (product-specific information and Environmental Product Declaration data), Holcim (asphalt production and embodied carbon data), and site construction records collected during installation.

The carbon profiles of materials have been calculated using the Future Highways Research Group (FHRG) tool Carbon Leadership Profiler (CLP) Toolkit (previously known as Carbon Analyser), an Excel-based tool developed by FHRG in collaboration with local highway authorities to provide a simple, standardised method for quantifying carbon emissions associated with transport and highways activities. This has been supplemented with the OneClickLCA database where embodied carbon data is otherwise unavailable. All carbon profiles have incorporated a local and sector-wide baseline material to benchmark carbon savings. The WinterPave trials have been evaluated against traditional winter maintenance required for de-icing i.e. salt gritting. To allow for direct comparisons within the carbon analysis, carbon modelling for winter maintenance routines will be based on data collected during winter 2024 as the business-as-usual approach.

The carbon evaluations for WinterPave are based on whole-life cycle assessments which consider:

- Embodied Carbon;
- Transportation emissions of materials and people;
- Operation of plant and equipment during construction, including operational electricity, fuel and water emissions;
- End of life emissions including deconstruction and waste processing.

Feature	Description	Carbon Intensity	Product Prospects
Material Summary	**Description of material**	**Specific emissions data (CO_2e per unit of material)**	**Brief product potential overview**
WinterPave - Iterchimica	WinterPave anti-freeze additive is included in bituminous mixtures in asphalt pavements to prevent the formation of ice along surfacing during winter months when temperatures drop. WinterPave was added to asphalt concrete, 6mm nominal aggregate size surface course mix at 4.2%.	WinterPave was trialled at two footway sites located in North Lanarkshire along Abbotsford Court and Marmion Road. At the Marmion site WinterPave had a carbon emission of 8.06 $kgCO_2e/m^2$ at the Abbotsford site and 8.90 $kgCO_2e/m^2$ at the Marmion site. While modelling based on gritting maintenance along the same footway over 15 years demonstrated 9.36 $kgCO_2e/m^2$. Showing a 14% reduction in carbon emissions for the Abbotsford site and a 5% reduction in emissions for the Marmion site.	In this trial WinterPave has shown the potential to be used on highway projects. Especially on those focusing on sustainability, decreasing carbon emissions and reducing winter maintenance expenses associated with maintaining pavements. The de-icing asphalt additive eliminates the requirement for traditional salt gritting in winter maintenance, delivering carbon savings over the pavement's service life (assumed 15 years in this analysis). This is achieved by reducing maintenance related emissions and offsetting initial embodied carbon through extended service life resulting from fewer freeze thaw related repairs.

Methodology

Trial Design

The WinterPave trials were designed to evaluate the performance, durability, and environmental impact of WinterPave and its suitability for widespread deployment on local roads across the UK, with a particular focus on North Lanarkshire Council.

Carbon emissions have been assessed based on the whole lifecycle stages A1-A5 (cradle to construction) in accordance with EN 15804. EN 15804 is the European standard that defines the rules and reporting format for Environmental Product Declarations (EPD) for construction products, providing a consistent, auditable framework for quantifying carbon impacts across a product's lifecycle. These stages cover raw material extraction, transport to and manufacture at the factory, delivery to site and on-site installation, see Figure 1. This clear separation of stages enables precise attribution of emissions to each segment of the supply chain, helping to identify areas for potential reduction measures and ensuring comparability across all trials. Operational carbon savings resulting from reduced salt use are attributable to lifecycle stages B1-B5 and are therefore excluded from the analysis presented in this report, which is concerned with procurement and construction emissions only.

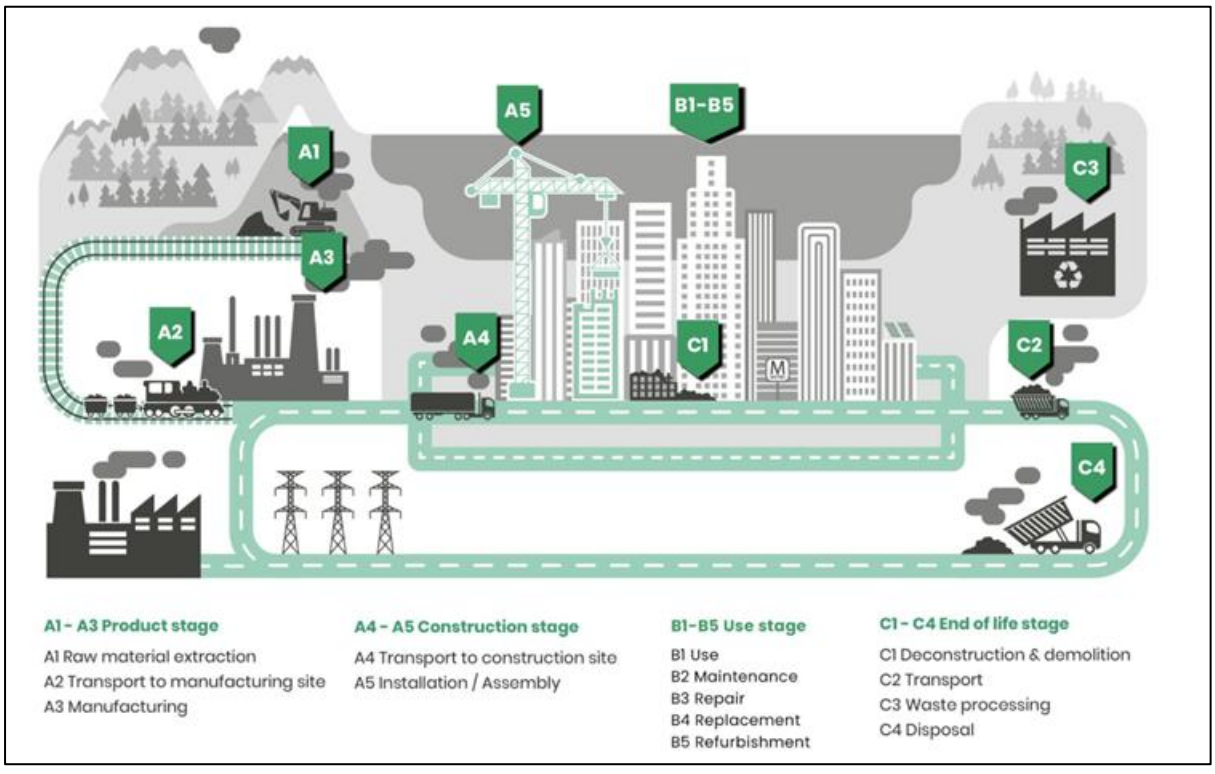

Figure 1: Carbon Lifecycle Stages[1]

[1] Life Cycle Stages | One Click LCA

Site Selection

The trial site was chosen based on the following criteria:

- **Site Location:** Two residential footways were selected in Abbotsford and Marmion, North Lanarkshire, Scotland.
- **Traffic Volume:** Sites which experience similar footfall, in residential areas, were selected.
- **Environmental Conditions:** Sites susceptible to winter icing conditions were included to evaluate the material's resilience.

Data Collection Plan

The following data items were collected to ensure a thorough evaluation of WinterPave during site trials:

DATA ITEM	UNIT(S)	RESPONSIBLE	LOCATION OF DATA	PURPOSE
Trial Location	Road name Coordinates of footways	Operational Staff	Live Labs 2 Teams	Technical comparisons
Conditions at the time of lay	Temperature (℃) Conditions (rain, dry, etc)	Operational Staff	Live Labs 2 Teams	Operational considerations and technical comparisons
Cost	Cost per m^2 of WinterPave in mix Cost per winter maintenance of benchmark footway (based on salt usage) Cost for winter maintenance of WinterPave footway	Amey procurement and Operational Staff	SAP	Purchase cost and whole lifecycle cost evaluation
Quantity	Kg of WinterPave used Percentage of WinterPave in mix Kg of salt used in standard gritting maintenance on a comparable footway	Operational Staff	Asset Management	Cost and carbon evaluations
Technical characteristics	-	Technical Lead and Academic Partner	Live Labs 2 Teams	Technical Evaluation
Operational Experience	Subjective – any concerns or benefits experienced by Operations Team	PM to host post-trial debrief with Operations Team	Case study in knowledge bank	Scalability evaluation
Operational Data	Time to complete (hh:mm) Number of staff required	Operational staff	LL2 Teams	Operational considerations and carbon evaluation
Fuel Usage	Litres of petrol used Type of plant/fleet used (electric, diesel, model)	Operational staff	Asset management	Carbon evaluation

Table 1: Data collection plan

Trial Location Plan

WinterPave has yet to be fully evaluated against traditional winter maintenance (salt rock gritting) in terms of carbon performance within North Lanarkshire. To establish a comprehensive comparison, initial trials are recommended to assess durability, emissions, and material efficiency. As salt gritting is the standard practice used by NLC, this will serve as the benchmark for carbon modelling.

The trial areas include residential footways as defined in the table below, with preference being given to locations that experience high levels of ice during winter months.

TRIAL SITE	FOOTWAY TYPE	TRIAL LOCATION	PRE-EXISTING SURFACE	TRIAL DESCRIPTION
1	Residential Footway	Marmion Road, North Lanarkshire, Scotland	Assumed to be traditional 70mm thick paving slabs on 25mm laying course and 100mm sub-base	1066m^2 of footpath
2	Residential Footway	Abbotsford Court, North Lanarkshire, Scotland	Assumed to be traditional 70mm thick paving slabs on 25mm laying course and 100mm sub-base	1646m^2 of footpath

Table 2: WinterPave trial information

Procedure

Site Preparation: The selected site was cleaned and prepared for the installation of WinterPave as per manufacturer's instructions.

Material Application: WinterPave was installed in accordance with manufacturer's instructions and specifications, ensuring consistent installation. The asphalt mixture containing the WinterPave additive was produced by Holcim at the Chryston Quarry asphalt plant before being transported to site for laying.

Monitoring and Data Collection: The trial sites will be monitored over a period of 12 months. Data on surface condition, material performance, and environmental impact were collected at regular intervals.

Performance analysis: The performance of WinterPave was evaluated based on criteria such as durability, resistance to traffic stress, and environmental impact. Comparisons were made against traditional winter gritting maintenance routines on asphalt pavements to benchmark performance.

Data Analysis

The collected data was analysed to determine the effectiveness of WinterPave in the local highways network in North Lanarkshire. Carbon modelling was used to evaluate the performance of WinterPave versus carbon modelling for conventional salt gritting along a similar residential footway. The analysis focused on:

- **Durability**: Assessing the longevity of the treated site and resistance to traffic and environmental stress;
- **Environmental Impact:** Evaluating the reduction in carbon emissions and use of recycled materials; and
- **Cost- Effectiveness:** Comparing the costs associated with WinterPave, including material, application, and maintenance costs.

The embodied carbon factors for the trialled materials have been provided by the supplier using their internal carbon calculation tool and supported from carbon factors sourced from OneClick LCA where required. An Environmental Product Declaration (EPD) has been produced and third party verified for WinterPave. The EPD has been completed by Eco Platform in accordance with ISO 14025:2006 and EN 15804+A2:2019/AC:2021 and third party verified by ACCREDIA.

The overall A1-A3 carbon emissions for WinterPave at a percentage of 4.2% in asphalt concrete (AC) 6mm nominal aggregate size surface course has been provided by Holcim and calculated using their verified carbon tool. This tool follows the principles of EN 15804 and has been third party verified by Circular Ecology Ltd. The tool uses primary activity data from Holcim operations, secondary data from the UK Government GHG emission factors and the Inventory of Carbon and Energy v4.0 by Circular Ecology and the University of Bath, with additional data supplied by Carbon trust.

This existence of an EPD with third-party verification and the use of a third party verified carbon calculation tool provides objective verification that WinterPave's A1-A3 emission factor has been calculated based on transparent, independently validated and whole-life carbon data. This positions WinterPave as a credible additive for asphalt pavements.

Carbon Appraisal

Carbon appraisal

Drawing on data collected through trials; a carbon assessment has been undertaken. Table 3 establishes the parameters of the model, defines assumptions and outlines product specifications.

ASSUMPTIONS	JUSTIFICATION
All transportation is undertaken via diesel HGV.	Based on standard modelling assumptions from similar schemes.
Unit of measurement used is '$kgCO_2e/m^2$'.	Based on the best available data used to conduct the carbon appraisal.
Traffic management activities were not included within this carbon assessment.	Traffic management differs between sites and local authorities so requires separate capturing, as part of standard practice.
Government emission factor for transport HGV, diesel 2025 was used to calculate A5 emissions for plant when a specific emission factor was unavailable.	Based on the best available data at the time of this carbon appraisal.
Where specific plant fuel usage or specific machine hour carbon emission factors were unavailable, emission factors have been selected based on plant weight, average kW power and loading factor, sourced from OneClick LCA.	Based on the best available data at the time of this carbon appraisal.
Carbon assessment of WinterPave analyses lifecycle stages A1-A5.	A comprehensive whole lifecycle analysis is not feasible at this stage due to the limited duration of the trial.
Vehicles transporting materials are assumed to travel fully laden to site and return empty.	The assumption that vehicles travel fully laden to site and return empty reflects standard haulage practice for material deliveries. Applying this assumption ensures carbon calculations accurately represent typical operational behaviour and avoid artificially reducing transport-related emissions.
Transport related emissions from outside the UK have been excluded from this carbon analysis.	Transport emissions occurring outside the UK have been excluded to ensure that the carbon analysis reflects the operational boundaries and decision-making influence of the local authority.
This carbon analysis does not incorporate planing operations within this assessment.	This is considered BAU and therefore is not influenced by this innovative material additive.
To calculate the CO_2e emissions per tonne of aggregate from each quarry, Holcim utilised the total energy consumption for Chryston quarry over the previous 12 months. Each quarry's energy use was converted to an equivalent CO_2 emission value then divided by the total tonnage of aggregate sold in that same period.	Based on the most up to date information the contracted asphalt manufacturer (Holcim) had available at the time of this carbon analysis.
Holcim utilised Eurobitume's 2025 carbon emission factor for bitumen, 530$kgCO_2e$/ tonne[2].	This figure is the most recent bitumen emission factor and is considered the industry standard.

[2] EB-GWP-Report-to-LCA-4.0-2025.pdf

ASSUMPTIONS	JUSTIFICATION
Fuel consumption of dryers has been calculated by the amount of fuel used divided by the tonnage of asphalt supplied. Giving the CO_2e value per tonne of asphalt mixed can vary from plant to plant based on tonnage supplied, fuel type, efficiency etc.	Based on the best available data at the time of this carbon appraisal.
The emission factor used for fibre pellets, a standard aspect of conventional asphalt manufacturing, was sourced from ASPECT.	Based on the most recent emission factors available to Holcim for emission factor calculation. Holcim's internal carbon calculation tool has been externally verified by Circular Ecology and follow the principles EN 15804.
The default emission factor used for RAP (reclaimed asphalt pavement) was sourced from ASPECT.	Based on the most recent emission factors available to Holcim for emission factor calculation. Holcim's internal carbon calculation tool has been externally verified by Circular Ecology and follow EN 15804 principles.
The emission factor used for limestone filler was sourced from ICE v.3 2020.	Based on the most recent emission factors available to Holcim for emission factor calculation. Holcim's internal carbon calculation tool has been externally verified by Circular Ecology and follow the principles EN 15804.
Machine hours are based on timings recorded in site diaries.	Machine hours have been derived from the timings documented in the site diaries because these records provide the most accurate, project-specific, and verifiable source of operational data available for the trial.
Vehicles transporting materials are assumed to travel fully laden to site and return empty.	The assumption that vehicles travel fully laden to site and return empty reflects standard haulage practice for material deliveries. Applying this assumption ensures carbon calculations accurately represent typical operational behaviour and avoid artificially reducing transport-related emissions.
Operational on-site data collected on the first day of works was extrapolated to represent the full four-day construction period.	The same processes were followed each day on site, and this has been supported by site diaries.
Lifecycle analysis of WinterPave assumes that existing footway was laid with a conventional AC 6 surface course, based on the A1-A5 carbon data from the same site as WinterPave in North Lanarkshire.	Based on standard footway laying practices in North Lanarkshire.
The carbon emission factor for Salt rock (used for gritting) was sourced from Carbon Cloud.	Based on the best available data at the time of the carbon assessment and has been verified by internally through a LCA by Carbon Cloud based on primary data from the producer.
Emission factor for conventional AC6 dense surface has been sourced from Holcim for material produced at the same Chryston Quarry asphalt plant. This material was not used as part of this NLC trial.	As both materials were manufactured at the same Holcim owned and operated quarry, it can be assumed that the production methodology, energy consumption and fuel use was similar. This was the best available data at the time of this carbon appraisal.

ASSUMPTIONS	JUSTIFICATION
Salt application from gritting is assumed to occur 40 times over the winter period annually.	Based on gritting records provided by NLC from January 2026 and professional experience of NLC personnel.
The gritting routine has been modelled over a 15-year maintenance period. This is assumed to be the approximate maximum service life of conventional AC6 dense surface course.	Based on PAS 2080 guidance[3].

Table 3: Carbon appraisal matrix

[3] 2023-03-29-pas_2080_guidance_document_april_2023.pdf

Carbon Modelling

The carbon modelling for the trials was conducted using the Future Highways Research Group (FHRG) Carbon Leadership Profiler Toolkit to process and analyse primary carbon data from the trials, detailing emissions from materials, transport, construction activities and equipment use. Using this information the tool generated carbon profiles to identify emission hotspots and improve accuracy by applying verified emissions factors from the toolkit's database.

Data sourced from WinterPave's EPD and OneClick LCA have been used to calculate lifecycle stages A1-A3. The OneClick LCA toolkit is in accordance with EN 15804 principles. Calculations accounted for material sourcing, and manufacturing for WinterPave additive at 4.2% content to asphalt concrete with 6mm nominal aggregate size.

Indicative results from carbon modelling for WinterPave at the Abbotsford and Marmion footways for lifecycle stages A1-A5 are expressed in $kgCO_2e/m^2$. This presentation of emissions enables direct comparison across different low-carbon innovations, to highlight carbon-efficient options and support data driven decision-making for reduction strategies. Results are presented graphically in Figure 2, Figure 4, Figure 4 and Figure 5:

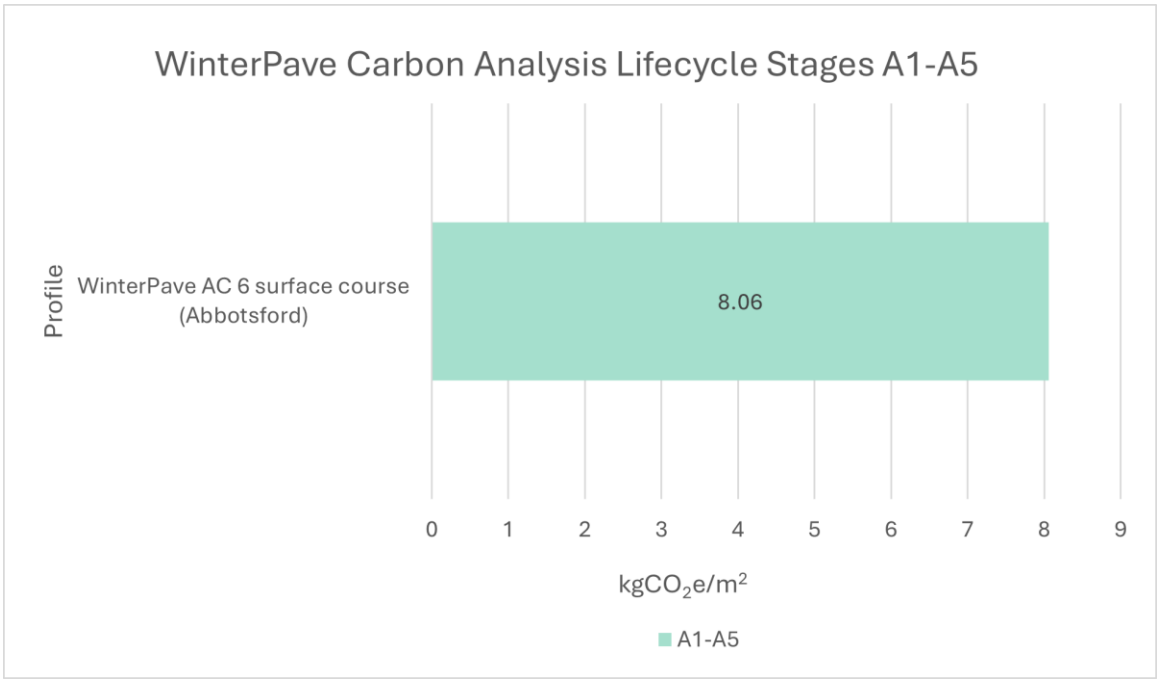

Figure 2: A1-A5 Lifecycle Stage Analysis of WinterPave, Abbotsford Footway per m^2

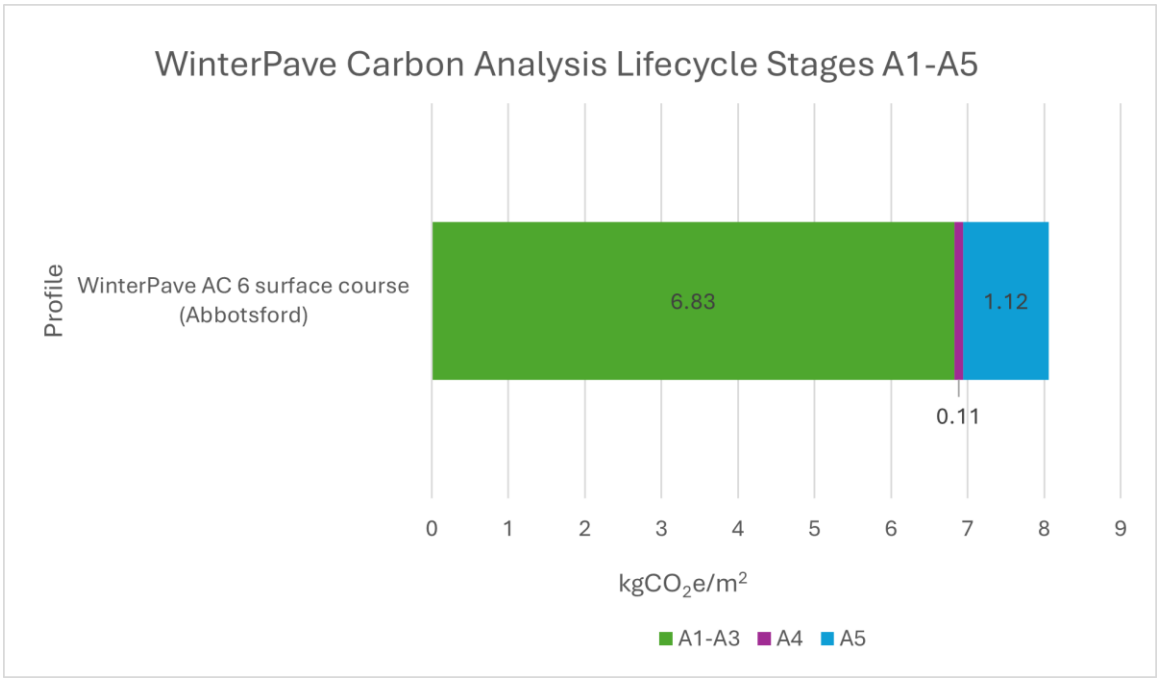

Figure 3: A1-A3, A4 & A5 Lifecycle Stage Analysis of WinterPave, Abbotsford Footway per m²

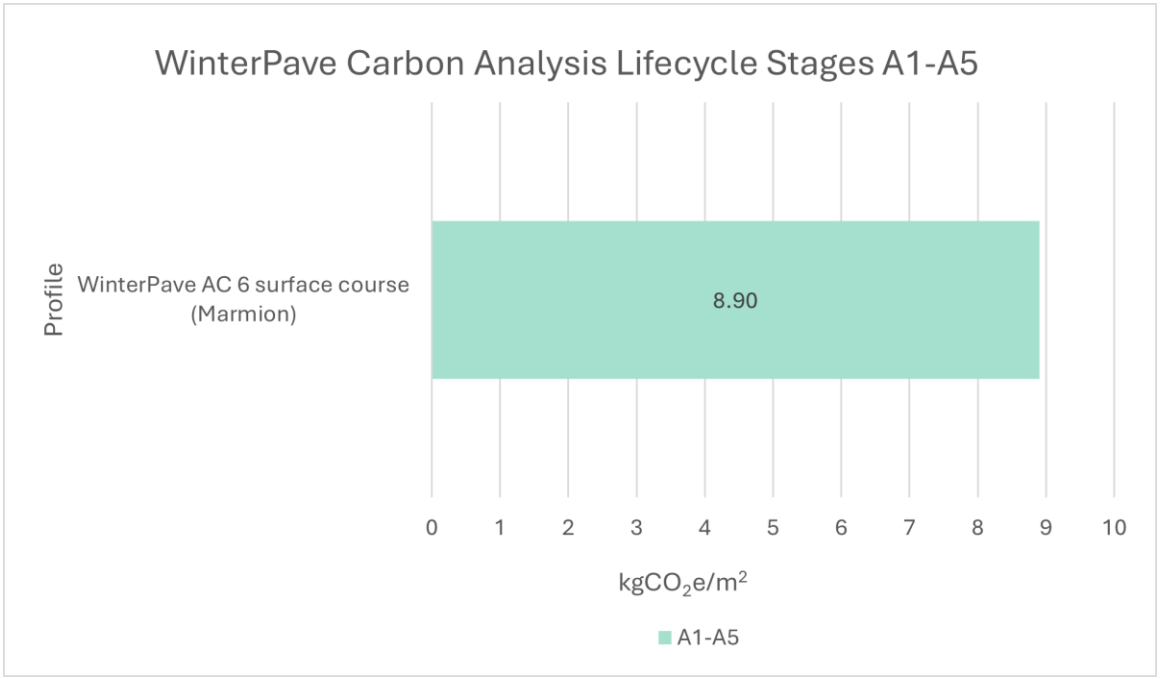

Figure 4: A1-A5 Lifecycle Stage Analysis of WinterPave, Marmion Footway per m²

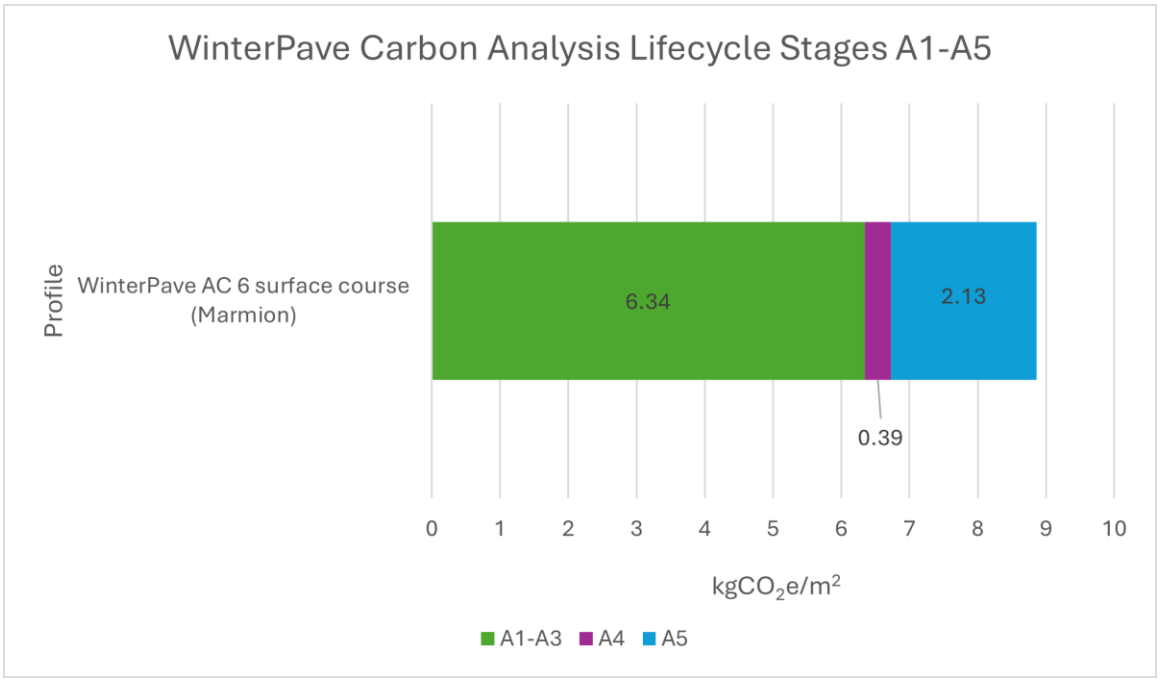

Figure 5: A1-A3, A4 & A5 Lifecycle Stage Analysis of WinterPave, Marmion Footway per m^2

Benchmarking

WinterPave is yet to be fully evaluated against traditional gritting maintenance in terms of carbon performance and long-term viability in North Lanarkshire as prior to this trial WinterPave had not been used on the local road network. These trials aim to compare the durability, carbon emissions, and material efficiency of WinterPave versus traditional gritting maintenance routines as the benchmark for this evaluation.

A comparative analysis has been undertaken to evaluate the use of WinterPave as an asphalt additive against the business-as-usual approach of gritting a conventional asphalt footway during winter months in North Lanarkshire. The assessment covers lifecycle stages A1-A5, covering lifecycle emissions associated with raw material extraction, transport to manufacturing, manufacturing, transport to site and construction of a new footway. In addition, lifecycle stage B2 covering maintenance emissions has been included to capture the impacts associated with routine winter gritting activities. This is key as while WinterPave results in a small increase in construction stage emissions, the potential carbon benefit arises from the reduction in winter maintenance requirements rather than from a lower carbon product composition. This approach enables a comprehensive comparison of the whole-life carbon performance of WinterPave relative to the conventional de-icing method for asphalt footway surfaces.

Indicative results from carbon modelling for WinterPave in comparison to gritting on a conventional footway surface are presented graphically in Figure 6 Figure 7, Figure 8 and Figure 9:

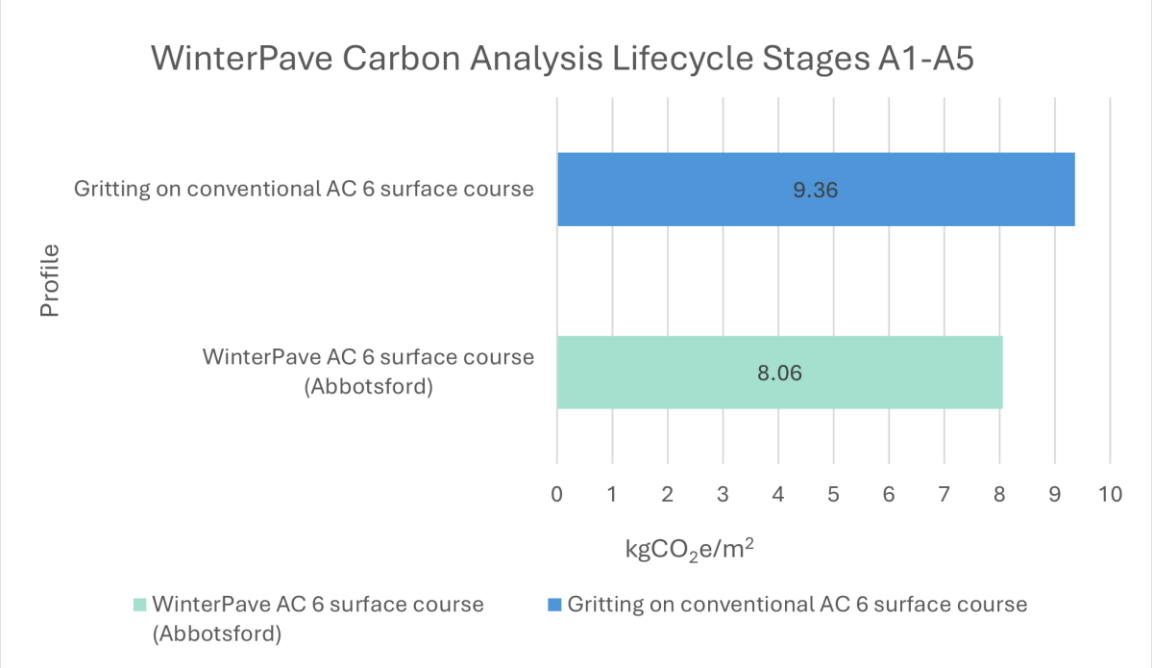

Figure 6: Comparison Analysis of A1-A5 Lifecycle Stage for WinterPave, Abbotsford Footway versus gritting on a conventional asphalt footway per m^2

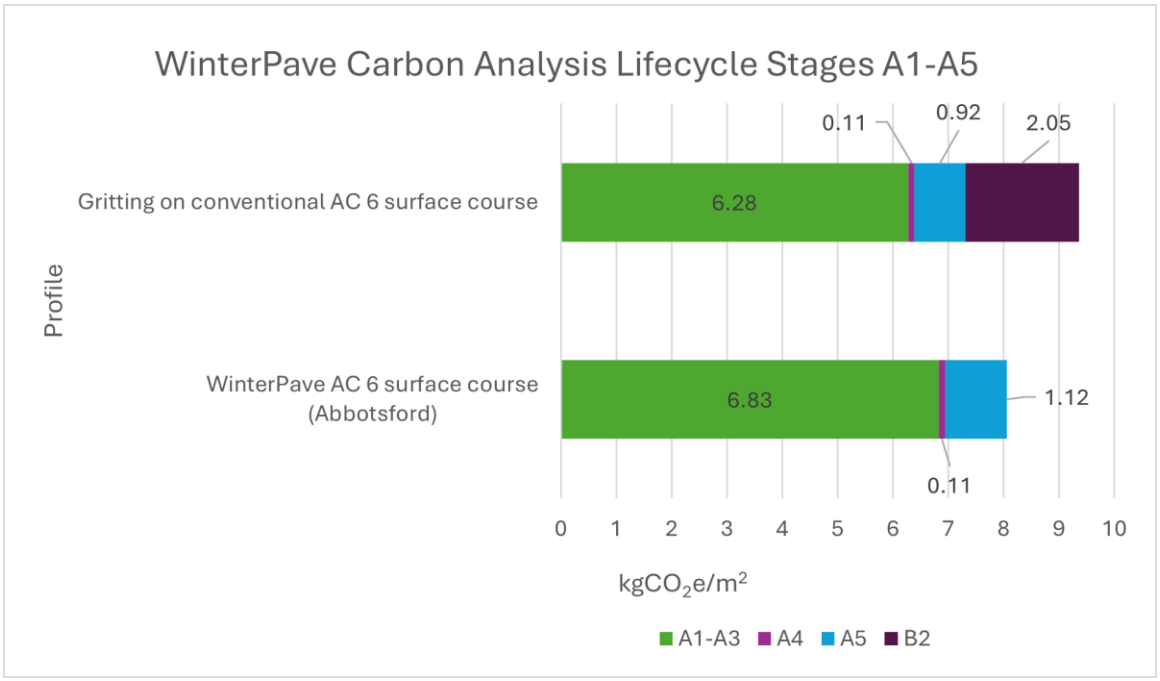

Figure 7: Comparison Analysis of A1-A3, A4, A5 Lifecycle Stages for WinterPave, Abbotsford Footway versus gritting on a conventional asphalt footway per m²

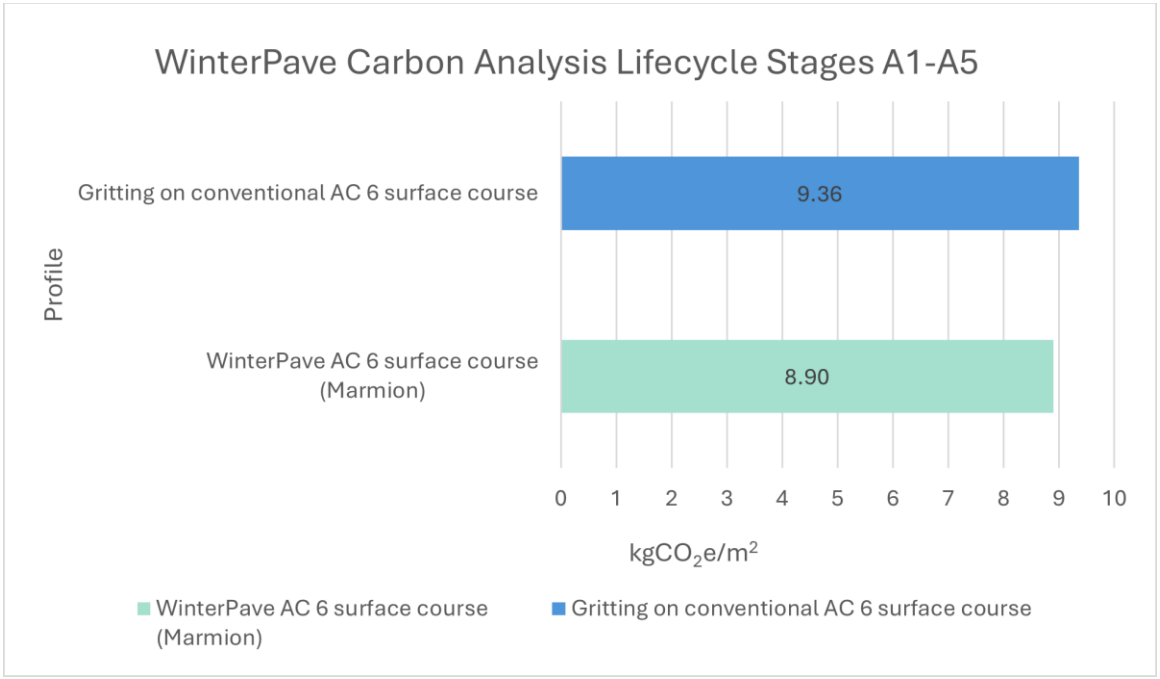

Figure 8: Comparison Analysis of A1-A5 Lifecycle Stage for WinterPave, Marmion Footway versus gritting on a conventional asphalt footway per m²

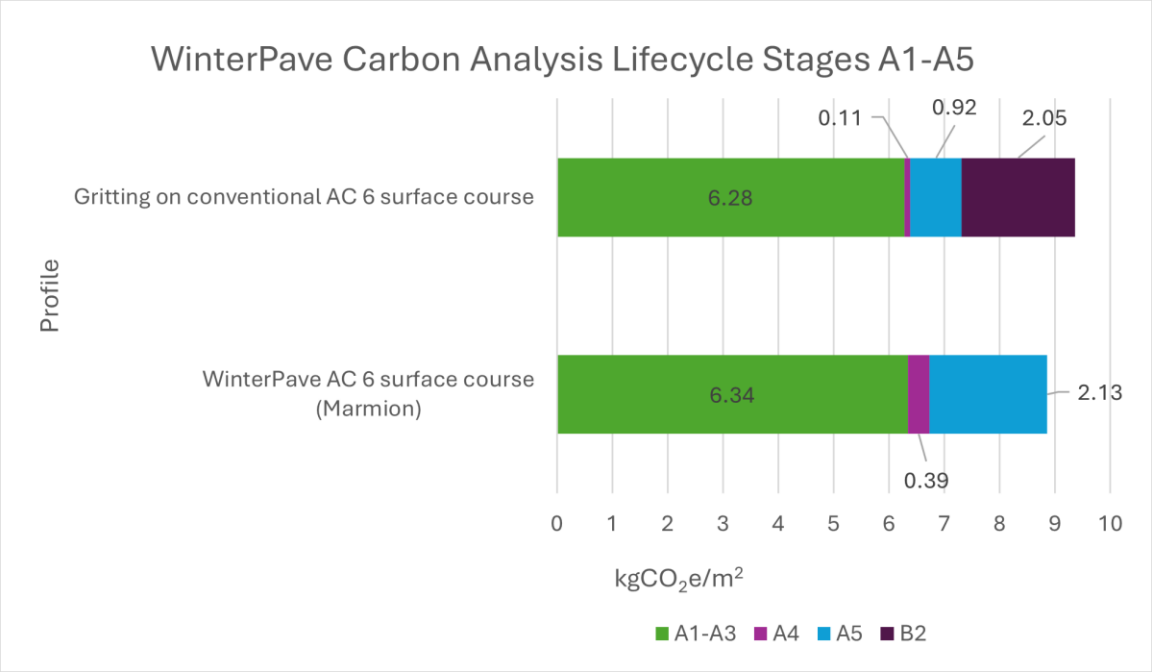

Figure 9: Comparison Analysis of A1-A3, A4, A5 Lifecycle Stages for WinterPave, Marmion Footway versus gritting on a conventional asphalt footway per m^2

Material	Composition	Applications	Performance	Installation	Sustainability
WinterPave	A standard surface asphalt mix that contains a proprietary WinterPave additive. The WinterPave additive is mixed into the asphalt during production, replacing a small percentage (typically 4-5% by weight) of the fine aggregate/sand portion. WinterPave works by reducing ice adhesion to the pavement without significantly altering the structural composition of the asphalt.	WinterPave is a functional enhancement to standard surface asphalt mixes. Primarily used in surface course applications where winter safety performance is important e.g. icy regions, steep hills, bridges, intersections etc. Often applied in targeted sections where ice/snow accumulation is a safety concern, rather than as the default surfacing.	WinterPave offers an anti-icing effect which reduces the adhesion of snow and ice to the surface, reducing gritting routines and improving safety. Reduces dependency on external de-icing salts/grits. The structural and skid performance of the modified asphalt remains similar to conventional asphalt. The additive does not alter primary pavement performance beyond winter enhancements.	Produced and laid using normal asphalt production and paving operations. WinterPave does not require specialised laying equipment or new construction practices. The additive is mixed before bitumen in batch plants of via feeder in continuous plants, after which normal mixing, transport and compaction proceed.	The sustainable characteristics of WinterPave are primarily tied to reduced winter maintenance impacts. It requires fewer de-icing salts/grits can reduce environmental damage from chloride runoff. The additive reduces carbon emissions through removing the requirement for gritting routes during winter months, reducing maintenance related emissions from plant and operatives.
Salt Gritting Routines	The underlying road surface is typically conventional asphalt, treated with rock salt (sodium chloride) or grit during the winter to temporarily chemically and mechanically modify the surface to improve traction and reduce ice formation. Effectiveness is dependent upon salt coverage, application rate, temperature and moisture.	Applied reactively or preventively on all types of roads: highways, rural roads and urban roads. Requires continuous maintenance during winter.	Anti-icing and increased traction is temporary and is easily washed away or dissolved in rain. Salt can accelerate asphalt and concrete degradation. Effectiveness decreases at very low temperatures (< -10°C).	No special construction required, roads are treated after surfacing. Requires seasonal storage, transport, and application equipment (gritting trucks, spreaders etc. Labour and resource intensive during winter months.	Carbon emissions from salt production, transportation, and application vehicles which occur annually. Due to the salt/grits temporary nature it requires repeated application during winter months which cumulatively over the surface life increases carbon emissions. Potential for salt runoff to damage surrounding biodiversity e.g. soil, vegetation and aquatic ecosystems.

*Table 4: WinterPave Appraisal**

*All factors assessed as part of the appraisal of WinterPave has been built on supplier provided and publicly available material and are not drawn from the live trial.

Life Cycle Stage	Baseline Carbon Emissions (salt gritting) ($kgCO_2e/m^2$)	WinterPave Carbon Emissions (Abbotsford) ($kgCO_2e/m^2$)	Difference (%) (Increase/ Reduction)
A1 – A3	6.28	6.38	1.56%
A4	0.11	0.11	0%
A5	0.92	1.12	21.78%
B2-B9	2.05	0	100%

Table 5: Life Cycle Stage comparison to BAU

Life Cycle Stage	Baseline Carbon Emissions (salt gritting) ($kgCO_2e/m^2$)	WinterPave Carbon Emissions (Marmion) ($kgCO_2e/m^2$)	Difference (%) (Increase/ Reduction)
A1 – A3	6.28	6.34	0.99%
A4	0.11	0.39	224.56%
A5	0.92	2.13	131.55%
B2-B9	2.05	0	100%

Table 6: Life Cycle Stage comparison to BAU

Carbon Benefits and Considerations (Matrix)

Table 7 presents the findings of the carbon benefits and considerations matrix for WinterPave. All scoring is **bold and underlined**.

Technical data used during benchmarking and the carbon benefits and considerations matrix were supplied by the manufacturer and are not derived from the WinterPave live trials in North Lanarkshire. While reliance on supplier-provided information may introduce uncertainty in confidence levels, the information and data represents the best available evidence at the time of the appraisal. Data quality has been considered when selecting supplier information and, where possible, supplier values were chosen from manufacturers' standard test reports, specifications and product datasheets that reference recognised test methods and certification.

BENEFIT/LOAD UNDER REVIEW	CONSIDERATIONS	SCORING SYSTEM	JUSTIFICATION
Costs	Transport, operational, material procurement	1 - Significant additional costs **2 - Costs approximate baseline** 3 - Costs significantly lower than baseline	Cost likely to increase slightly due to added cost of the additive that does not follow BAU approach. However, the proportion of WinterPave is modest and does not meaningfully change plant operations. Therefore, costs are considered to be slightly above the baseline however not significantly above.
Maintenance	Design life, maintenance burden, on time for plant	1 – Significantly more maintenance/lower longevity 2- Approximately same maintenance/similar longevity **3 – Significantly less maintenance/higher longevity**	The additive prevents the formation of frost on the surface, preventing the need for gritting and reducing the maintenance burden during winter months.
Scalability	Manufacturing facilities	1 - Lab testing only **2 - In process of commercialisation w. small scale manufacture** 3 - Already has market presence with developed supply chain	WinterPave is an Italian product and has market presence in Europe, however, is considered relatively new in the UK with no manufacturing facilities in the UK.
Compliance with specifications	Requirements for standards departures	1 - Requires significant departure(s) from standard and has not been used before by end client **2 - Requires some departure from standard, but has been used before by end client** 3 - Does not require any departure from standard.	Additive modified mixes can sometimes require minor departure from standard asphalt specifications, but such potential departures are not expected to be significant.
Environmental	Nature-based solution	1 - Would have significant net disbenefit for environmental factors (noise, AQ, biodiversity, landscape etc)	Has potential to reduce air pollution due to reducing the requirement for

BENEFIT/LOAD UNDER REVIEW	CONSIDERATIONS	SCORING SYSTEM	JUSTIFICATION
		2 - Would have negligible net benefit/disbenefit or no overall change regarding environmental factors 3 - Would have significant net benefit/disbenefit for environmental factors.	regular gritting routines along routes using the additive.
	Road noise	1 - Would have significant net disbenefit **2 - Would have negligible net benefit** 3 - Would have a significant net benefit	Has potential to reduce operation road noise due to less plant required for gritting routines.
	Climate resilience/future proofing	1 - Would have significant net disbenefit 2 - Would have negligible net benefit/disbenefit or no overall change regarding **3 - Would provide a significant net environmental benefit**	Provides meaningful resilience benefits in winter conditions by preventing ice formation and reducing damage from freeze thaw cycles.
Risk and safety	H&S impacts, safety testing data	1 - Would present increased risk or safety versus BAU option 2 - Would present no overall risk increase or safety impact versus BAU option **3 - Would present lower risk or safety impact versus BAU option.**	Reduced ice formation directly improves skid resistance and lowers collision risk in winter. No new operational hazards introduced when added at low percentage.
Technology Readiness Level	Is it commercially available, is there enough R&D?	1 - Not yet commercially available 2 - Commercially available from worldwide suppliers **3 - Commercially available from European suppliers** 4 - Commercially available from UK suppliers 5 - Commercially available from local suppliers	Additive-based winter-resilient asphalts are commercially available from European suppliers in Italy but may not yet be produced widely in the UK.
Constructability	How easy is it to handle on site, install, recover, curing time, specialist equipment/training, storage?	1 - Specialist contractors, time on site and/or equipment required **2 - No considerations required above and beyond baseline solution** 3 - Significant benefits to on-site activity / ease of installation	Asphalt production and laying remain essentially unchanged, but incorporation requires controlled batching and quality assurance at the plant.
Supply Chain	Material availability	1 - Novel materials used with limited supply **2 - Materials are available with some supply restrictions**	WinterPave relies on specialised additive manufacturing; supply is available but dependent on additive producer capacity.

BENEFIT/LOAD UNDER REVIEW	CONSIDERATIONS	SCORING SYSTEM	JUSTIFICATION
		3 - Materials are readily available	
Circular Economy	Recycled content	**1 - Virgin materials are used with little or no recycled content** 2 - Materials contain a level of recycled content 3 - Materials are predominantly recycled and/or use novel sources of recycled content that would otherwise be discarded as waste	WinterPave itself is not recycled content and does not increase recycled content within the mix.
	Ease of recycling	1 - Minimal recycling of material possible upon removal **2 - Limited recycling is possible and/or significant reprocessing required** 3 - Reuse/recycling is easy and convenient	Additive presence does not prevent asphalt planing reuse, but small chemical additions may require consideration during reprocessing.

Table 7: Carbon benefits and considerations matrix

Long-Term Performance Analysis

The carbon analysis within this report do not include lifespan analysis. This will be finalised dependent upon the publishing of longevity test results in partnership with the University of Nottingham.

These tests will focus on the following:

- Durability and Aging Resistance,
- Skid Resistance and Surface Integrity,
- Lifecycle Carbon Savings,
- Traffic and Environmental Stress Testing,
- Optimal Reapplication Intervals.

Conclusion & Recommendations

Conclusion

The evaluation of WinterPave undertaken as part of the Live Labs 2 programme has demonstrated that the asphalt additive holds potential to reduce carbon emissions associated with winter footway maintenance when compared to the business-as-usual approach of repeated gritting with salt rock. The addition of Winterpave to the asphalt mix results in a marginal increase in A1-A5 lifecycle stage emissions (incorporating raw material, transport to manufacturing, manufacturing, transport to construction and construction), these upfront emissions are offset over the assumed service life of the footway. This is achieved through the removal of winter gritting activities, resulting in overall carbon savings in both trial sites.

Carbon modelling shows an overall reduction in carbon emissions of 14% at Abbotsford Court and 5% at Marmion Road over assumed service life of 15 years. The variations in these reductions can be attributed to site-specific construction constraints and waste production at the differing sites, particularly at the Marmion Road site, where an additional day on site was required. These findings support that WinterPave can offer measurable carbon savings when applied to residential footways where winter maintenance demand is high.

The trial has shown that WinterPave can be manufactured, transported and installed using standard asphalt production and laying practices, with no requirement for specialist plant or significant procedural changes. However, it should be noted that relatively high volumes of waste were experienced at both sites, 5.4t at Abbotsford Court and 1t at Marmion Road due to the WinterPave, primarily due to asphalt mix cooling rapidly and becoming unsuitable for laying. However, this has been identified as an operational issue rather than a material limitation and could be mitigated through targeted training and improved laying efficiency if WinterPave was adopted as BAU in North Lanarkshire.

Additionally, the anti-icing properties of the additive provide further operational and safety benefits by reducing the reliance on reactive gritting, improving winter resilience, and lowering risks associated with ice formation on pedestrian routes. Overall, the trials support the material's constructability and operational viability within existing local authority delivery frameworks with minimal operational adjustments required.

This evaluation identifies several limitations that restrict the confidence in long-term conclusions and therefore supports the need for further investigation. The trial duration does not yet allow for definitive assessment of durability, ageing behaviour or performance consistency across multiple winters. Furthermore, at this stage of assessment has not fully quantified carbon impacts beyond material production, construction and maintenance, this includes end-of-life and recycling pathways.

Overall, WinterPave can be considered a promising low-carbon innovation for asphalt mixes, with specific evidence supporting its use in asphalt footway applications. The trial results indicate that incorporating WinterPave at low percentages can reduce overall carbon emissions by removing the need for repeated routine salt gritting during winter maintenance.

Recommendations

It is recommended that robust long-term monitoring (over 5+ years) be implemented at the Abbotsford and Marmion sites to evaluate performance and verify lifecycle carbon savings. Long-term monitoring will allow for more expansive carbon modelling to assess durability, service life of anti-icing properties and end of life scenarios to provide a more comprehensive understanding of whole life carbon emissions. It is also advised that a structured end-of-life validation programme is established that demonstrates the recyclability of asphalt including WinterPave under real-world recovering and reprocessing flows.

Further trials are recommended to incorporate WinterPave into road asphalt surface course mixes with the aim of assessing more demanding operational conditions. These trials should focus on evaluating the additive's durability, anti-icing effectiveness, skid resistance, and long-term surface integrity when used in carriageway applications, as well as its impact on carbon emissions relative to conventional winter maintenance practices. Testing WinterPave within road surface courses would provide a more comprehensive understanding of its suitability beyond footways and support evidence-based decisions on its potential adoption across a wider range of highway assets.

For the purpose of this evaluation, WinterPave has been modelled on the assumption that routine gritting is no longer required on the treated footway sections. The conventional maintenance scenario assumes 40 salt applications per winter season over a 15-year service life, whereas the WinterPave scenario assumes no routine salt applications during the same period. On this basis, the model represents a 100% reduction in routine salt use compared with the conventional approach. However, this remains a modelling assumption and should be validated through long-term performance monitoring over multiple winter seasons.