



Centre of Excellence
for Decarbonising Roads




SPL IN-SITU RECYCLING LIVE TRIAL EVALUATION REPORT

Live Labs 2 North Campus

This report presents the findings of a live trial evaluating SPL In-situ Recycling. During the trial SPL used two different methods of in-situ recycling to highlight their potential carbon savings. Trial results produced 7.12 kgCO₂e/m² for HEVA Sol 4% binder and 30.77 kgCO₂e/m² for CEM II 4% binder with the overall trial site producing 10.14 kgCO₂e/m². Overall, the trials demonstrated that in-situ recycling shows high potential for decarbonising the local road network.

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Executive Summary

This report evaluates a live trial conducted as part of the wider Live Labs 2 project, which aims to test innovative highway solutions to improve road performance, reduce maintenance needs, and enhance safety. This specific trial focused on medium in-situ recycling undertaken by SPL. SPL delivered in-situ recycling on two sections of the binder course of the Supersite Trial (a single stretch of highway trialling several materials and techniques) along Hirst Road in North Lanarkshire. Medium in-situ recycling is a cold, on-site pavement rehabilitation process, delivered at a depth of 150mm, that reuses the existing carriageway material with the addition of a reduced percentage of new binder.

SPL claim that carbon savings can be achieved through the cold, on-site recycling method which avoids the need for a hot-mix plant, cutting plant fuel use and carbon emissions compared with full-depth hot-mix reconstruction. By reusing existing material and requiring binder additions as low as 2% (depending on site conditions and design), the method reduces material inputs and carbon. It also significantly lowers haulage, with fewer lorry movements than ex-situ recycling, speeding up programmes and reducing traffic disruption.

This report assesses carbon emissions across material extraction 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.

The findings from the trial demonstrate potential for significant carbon savings by use of cold in-situ recycling when compared with conventional binder replacement methods. The trial produced carbon intensities of 7.12 kgCO₂e/m² for HEVA Sol 4% and 30.77 kgCO₂e/m² for CEM II 4% with the overall trial site producing 10.14 kgCO₂e/m².

Introduction

This Evaluation Report provides a high-level assessment of in-situ recycling completed by Stabilised Pavements Limited (SPL), an emerging sustainable method in highways, construction and maintenance, focusing on its environmental impact, product viability, and alignment with future infrastructure 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, focusing on how to decarbonise local highways infrastructure and assets. As part of this initiative, North Lanarkshire Council (NLC) are working alongside Transport for 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 disseminating 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 operational efficiency in infrastructure development.

The carbon profiles of materials have been calculated using the Future Highways Research Group (FHRG) tool Carbon Leadership Profiler Toolkit (previously known as Carbon Analyser), an Excel-based tool developed in collaboration with local highway authorities to provide a simple, standardised method for quantifying carbon emissions associated with transport and highways activities, and the OneClickLCA database where embodied carbon data is otherwise unavailable. All carbon profiles incorporate a locally relevant baseline material to enable benchmarking against standard industry practice. In-situ recycling trials have been evaluated against conventional practices used as part of a traditional binder replacement programme.

The carbon evaluations for SPLs in-situ recycling methods consider material extraction to construction lifecycle stages (A1–A5) which include:

- 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 ₂ e per unit of material)	Brief product potential overview
<p>In-situ Recycling (Regen) – SPL</p>	<p>SPL offer a variety of medium in-situ recycling options. On the Supersite trials Regen was trialled using two different materials: HEVA-Sol and CEM II 4%. Regen is a cold, on-site pavement recycling process that reuses the existing binder course of the carriageway with minimal new binder.</p> <p>To complete the process the existing pavement is milled on-site, stabilised with the addition of a binder (in this trial HEVA Sol 4% and CEM II 4%), compacted and then re-laid. This process recycles up to 100% of the existing binder course material.</p>	<p>SPL medium cold in-situ recycling during the live trial produced 10.14 kgCO₂e/m² (HEVA Sol 4% and CEM II 4%).</p> <p>In-situ recycling with the HEVA Sol 4% binder produced 7.12 kgCO₂e/m² and CEM II 4% produced 30.77 kgCO₂e/m².</p> <p>Results from this trial showed an overall 59.10% reduction in material extraction to construction carbon emissions when compared to traditional asphalt reconstruction.</p> <p>The majority of this reduction can be attributed to the HEVA Sol 4% binder which demonstrated a 71.28% reduction in emissions.</p>	<p>It is considered that, this product has demonstrated potential to reduce emissions and materials use in the road construction and maintenance industry, particularly in projects prioritising sustainability.</p> <p>The trial has demonstrated that the HEVA Sol binder used for insitu recycling results in measurable carbon reductions when compared with conventional practices.</p>

Methodology

Trial Design

The SPL in-situ recycling trail was designed to evaluate the performance, durability, and environmental impact method. The trial was conducted as part of the larger Supersite trial (a single stretch of highway trialling several materials and techniques), which focussed on testing innovative low-carbon surfacing materials and in-situ recycling techniques to evaluate their carbon savings and long-term performance under real-life road conditions. SPL binder insitu-recycling methods was used along sections 5 and 6 of the Supersite trial. SPL used two different materials for in-situ recycling; HEVA-Sol 4% and CEM II 4%.

Carbon emissions have been assessed based on the whole lifecycle stages A1-A5 (material extraction 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.

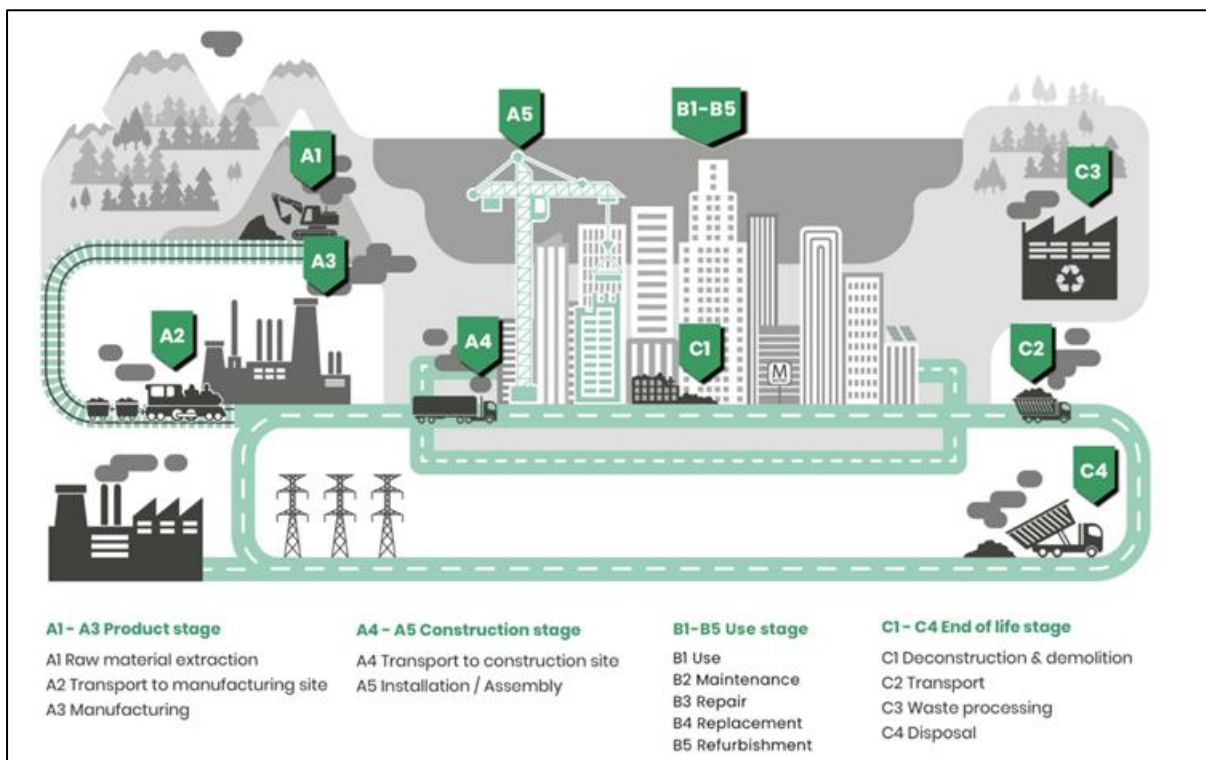


Figure 1: Carbon Lifecycle Stages¹

¹ [Life Cycle Stages | One Click LCA](#)

Site Selection

The trial sites were chosen based on the following criteria:

- **Traffic Volume:** The site was chosen as it experiences high volumes of both light and heavy vehicles allowing for the assessment of the material's performance under differing stress conditions.
- **Environmental Conditions:** The Supersite site was selected due to its varying weather conditions (e.g., temperature, humidity) to evaluate the surfacing material's resilience.
- **Surface Type:** Sites were all originally laid with hot-rolled asphalt (HRA) and asphalt concrete (AC20) binder course that had deteriorated with use and age to the point where they required maintenance..

Data Collection Plan

The following data items were collected to ensure a thorough evaluation of SPL binder in-situ recycling during site trials:

DATA ITEM	UNIT(S)	RESPONSIBLE	LOCATION OF DATA	PURPOSE
Trial Location	Road name, Road Type (A, B, C), Coordinates of location of HEVA- Sol 4% and CEM II 4%	Operational Staff	Site Diary	Technical comparisons
Conditions at the time of lay	Temperature (°C) Conditions (rain, dry, etc)	Operational Staff	Site Diary	Operational considerations and technical comparisons
Coring	Pen Softening Point DSR	University of Nottingham	Site Diary	Technical Evaluation
Road Surface Temperature	Temperature (°C)	Inspector	Site Diary	Technical Evaluation
Quantity	m ² of HEVA-Sol 4% and CEM II 4% used	Operational staff & Carbon Lead	Site Diary	Cost and Carbon Evaluations
Cost	£ for HEVA-Sol 4% and CEM II 4% £ for conventional resurfacing	Amey Procurement and Suppliers	SAP	Purchase cost and whole lifecycle cost evaluation
Line Characteristics	Length and Width (cm)	Carbon and/or Technical Lead	Site Diary	Technical and Carbon Evaluation
Operational Experience – ease of installation	Subjective – any concerns or benefits experienced by Operations Team	Project Manager to collect on-site data with Operations Team	Case Study in knowledge bank	Scalability Evaluation
Health & Safety	Ease of installation on-site Temperature required for installation	Operational staff and supplier information	Site Diary	Health and Safety Assessment
Operational Data	Time to complete (hh:mm)	Operational Staff	Site Diary	Operational considerations and carbon evaluation
Fuel Usage	Litres of petrol used Type of plant/fleet used (electric, diesel, model)	Operational Staff	Site Diary	Carbon evaluation

Table 1: Data collection plan

Trial Location Plan

The primary aim of the Supersite trials is to undertake a comparison analysis of surface courses with the current benchmark used by NLC, traditional HRA. There were a total of eight trial sections along one site (Hirst Road), with six surface courses and two binder courses on the main straight stretch of the carriageway and a further two surface course sections at junctions – SPL’s in-situ recycling methods were tested on sections 5 and 6. All trial sites were completed on one B classification of road (Hirst Road).

TRIAL SECTION	BINDER COURSE			SURFACE COURSE			
	MATERIAL/METHOD	DEPTH (MM)	SUPPLIER	PRIMARY MATERIAL	INNOVATION	DEPTH (MM)	SUPPLIER
1	In-situ Recycling	110	Colas	HRA	GiPave	50	Iterchemica/ Holcim
2	In-situ Recycling	110	Colas	HRA	Styrelf bio-PMB	50	Total /Holcim
3	In-situ Recycling	110	Colas	HRA (warm mix)	Traditional Surface HRA 35/14	50	Holcim
4	In-situ Recycling	110	Colas	HRA	HRA 35/14 Warm Mix	50	Holcim
5	In-situ Recycling	4% CEM II and 4% calcined clay binder (150mm HBM recycled layer)	SPL	HRA	UltiPave Bio	50	Tarmac/ Holcim
6	In-situ Recycling	4% CEM II and 4% calcined clay binder (150mm HBM recycled layer)	SPL	HRA (warm mix)	HRA 35/14 Warm Mix	50	Holcim
Junction 1	Traditional Binder	60	Hochtief	14mm HardiPave	HardiPave	40	Miles Macadam
Junction 2	Traditional Binder	60	Hochtief	14mm MilePave PMB	MilePave	50	Miles Macadam

Table 2: Supersite trial information

Procedure

Site Preparation: The selected sites were cleaned, prepared and planned for the trial. Loose debris and water were removed to ensure proper adhesion.

Material Application: Roads were prepped as per manufacturer's instructions prior to the products application. All materials are applied in accordance with manufacturer's instructions and specifications. The two in-situ recycling binder materials using the same process were completed by SPL employees who were trained to install the material.

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

Performance analysis: The performance of SPL's in-situ recycling was evaluated based on criteria such as durability, resistance to traffic stress, and environmental impact. Comparisons were made versus traditional binder resurfacing to benchmark performance.

Data Analysis

The collected data was analysed to determine the effectiveness of HEVA-Sol 4% and CEM II 4% as in-situ recycling methods acting as an alternative to conventional asphalt binder course replacement. Statistical methods were used to evaluate the performance of SPL's in-situ recycling methods versus a control section (traditional binder course replacement) along the same road. 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 in-situ recycling, including material, application, and maintenance costs.

The embodied carbon factors for trialled materials have been developed based on supplier product data and supported by carbon factors sourced from OneClick LCA for the same or similar materials where required. The carbon emission factor for HEVA-Sol 4% is sourced from a third-party verified EPD and CEM II 4% is calculated using a third-party verified EPD for Portuguese 'Grey' Cement and Mineral Products Association 'Embodied CO₂e of UK cements' guidance built from EPDs in accordance with EN 15804. It must be noted that the EPD for HEVA Sol expired in 2020, it should be of a high priority that the supplier (Hoffman Green Cement Technologies) gain an updated EPD to ensure accurate carbon reporting.

The existence of EPDs and the use of industry standard validated emission factors helps to provide objective verification that SPL's carbon reduction claims are based on transparent, independently validated, and whole-life carbon data. This positions SPL in-situ recycling as a credible alternative to conventional asphalt binder course resurfacing.

Carbon Appraisal

Drawing on data collected through the 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 ₂ e/ m ² '.	Based on the best available data used to conduct carbon appraisals.
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.
Carbon analysis incorporates emissions associated with the planning of the carriageway prior to SPL's in-situ recycling activities.	This follows BAU approach required prior to in-situ recycling.
Additional resources required solely to facilitate this Live Labs trial have been excluded from this analysis, as they do not represent SPL's business-as-usual approach.	Live Labs 2 is a nationally significant programme, which necessitated additional on-site resources. However, this analysis focuses on business-as-usual carbon performance to ensure the findings are applicable and meaningful for local authorities across the UK.
Comparative analysis assumes that planings from the benchmark binder course were used in asphalt RAP production.	Evidence supplied by the site teams demonstrates that the planings were used for the purpose of RAP production. It has been confirmed that 100% of the planings were used.
Planing data has had a multiplier of two applied to represent a two-day programme for traditional binder-course resurfacing.	This ensures the analysis aligns with the realistic operational practice on site and provides a representative estimate of planning-related carbon emissions.
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.
Carbon emission factor for CEM II has been provided by Cemblend via SPL.	This emission factor was calculated using a third-party verified EPD for Portuguese 'Grey' Cement and Mineral Products Association 'Embodied CO ₂ e of UK cements' guidance built from EPDs. The methodology and calculations have been provided to support this figure, showing high transparency.
Electricity use was not able to be recorded during the manufacturing of CEM II and has therefore been excluded from the carbon emission factor.	This would be small and unlikely to significantly affect the overall carbon emission. This was the best available data at the time of this carbon appraisal.
Fuel related emissions were allocated between CEM II and HEVA-Sol in proportion to the area of the site each material covers.	Allocating emissions by site area is a transparent method that matches the functional basis when the two materials are used to cover the same surface.
Emission factor for Asphalt Concrete has been sourced from Holcim from a different CEDR trial in North Lanarkshire.	It can be assumed that similar production methodology, energy consumption and fuel use were used.
The baseline AC20 binder course was applied at a depth of 60mm while SPL in-situ recycling was completed at a depth of 150mm.	A depth of around 60mm is typical for an AC20 binder course in UK local road maintenance, making it an appropriate and realistic baseline for comparison. In-situ recycling requires further depth to ensure the restructure and to stabilise the full treatment layer.
Carbon modelling with the use of Biodiesel HVO, the out-of-scope emission factor was used to account for CO ₂ associated with fuel combustion.	This follows the figures and guidance given in the UK Government's GHG Conversion factors 2025.

Modelling also assumes the same amount of conventional diesel and biodiesel HVO would be required to facilitate the works.	
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Table 3: Carbon appraisal matrix

Carbon Modelling

The carbon modelling for the trials was conducted using the Future Highways Research Group (FHRG) Carbon Leadership Profiler Toolkit to collect 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 that identified key emission hotspots. The toolkit's emission database was also used to provide verified emission factors and improve data accuracy.

One Click LCA was also utilised in modelling to support the FHRG Carbon Leadership Profiler Toolkit due to its large database of emission factors supported by Environmental Product Declaration (EPD). The carbon emission factor for HEVA-Sol 4% is sourced from a third-party verified EPD and CEM II 4% is calculated using a third-party verified EPD for Portuguese 'Grey' Cement and Mineral Products Association 'Embodied CO₂e of UK cements' guidance built from EPDs in accordance with EN 15804.

Indicative results from carbon modelling for the SPL in-situ recycling works at Hirst Road have been expressed. This presentation of emissions enables direct comparison across low-carbon innovations, to highlight carbon-efficient options and support data driven decision making.

Results are presented graphically in Figure 2, Figure 3, Figure 4, and Figure 5:

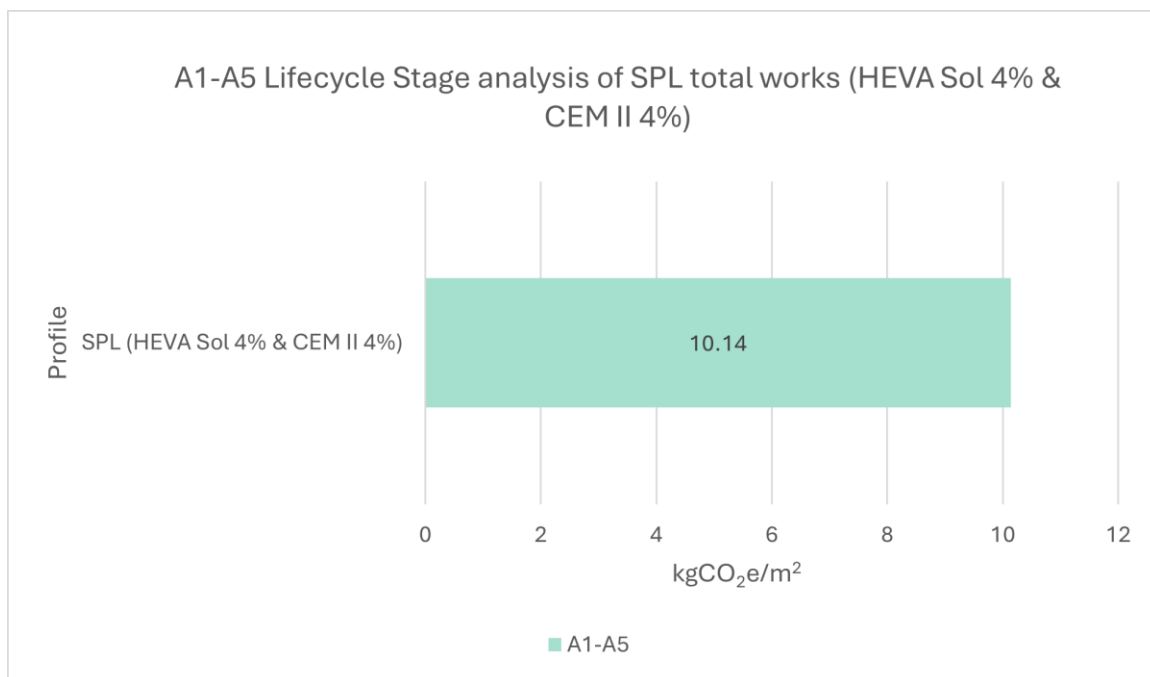


Figure 2: Carbon analysis of the total SPL in-situ recycling Hirst Road, North Lanarkshire per m²

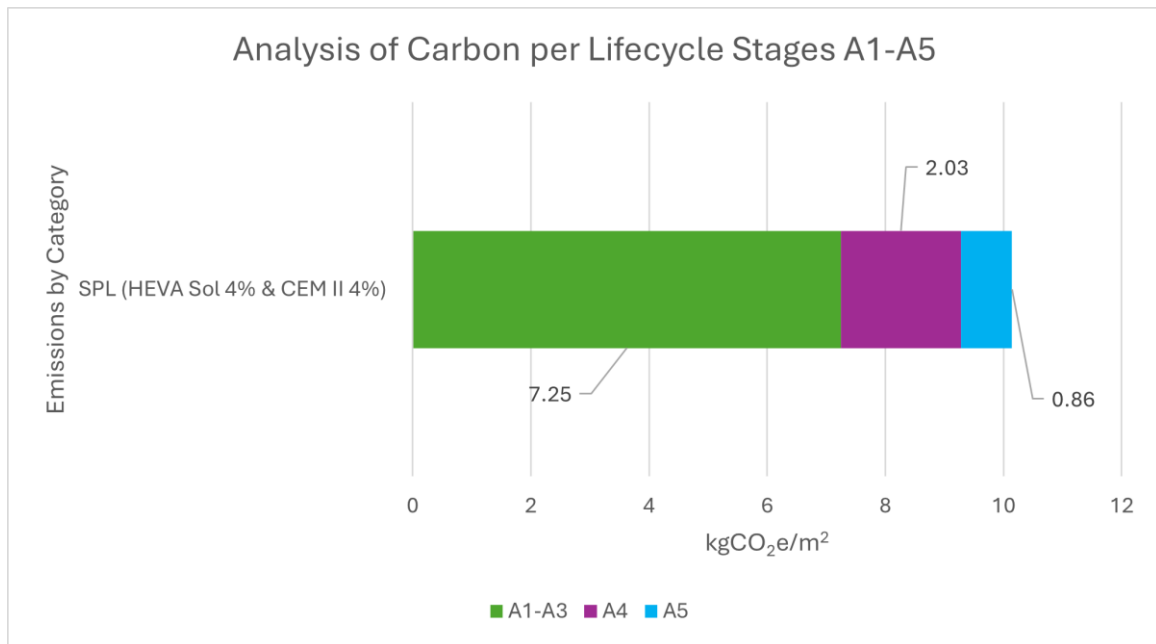


Figure 3: Carbon analysis of the total SPL in-situ recycling lifecycle stages A1-3, A4, A5 per m²

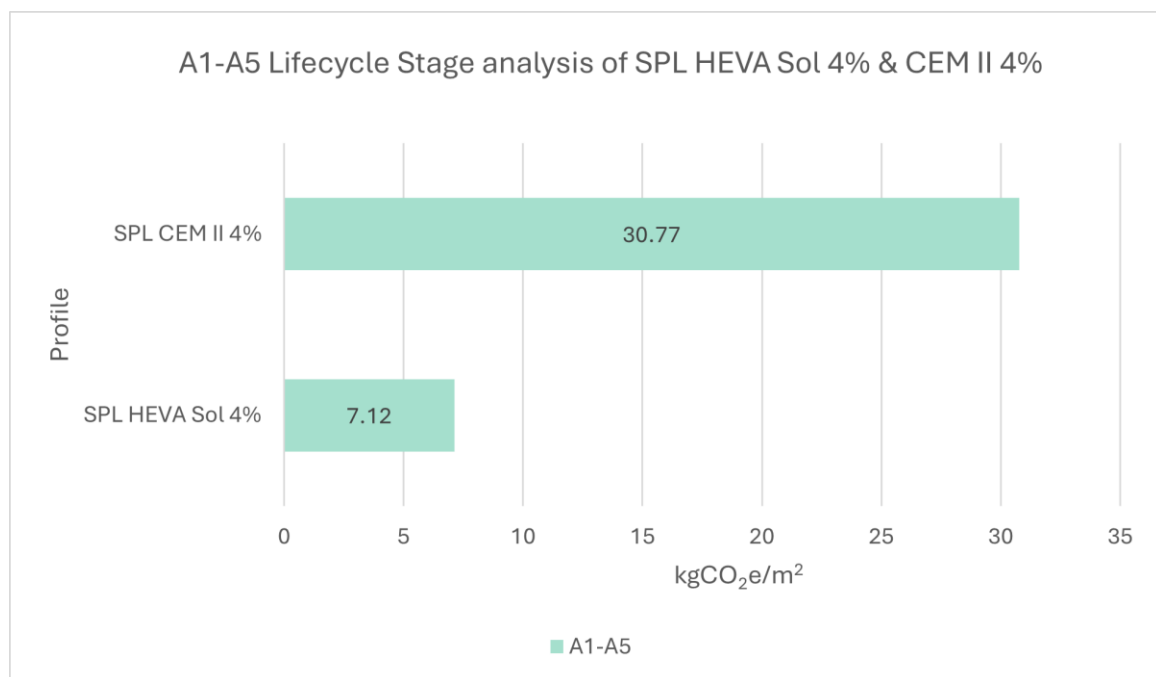


Figure 4: Carbon analysis of SPL in-situ recycling HEVA Sol 4% & CEM II 4% Hirst Road, North Lanarkshire per m²

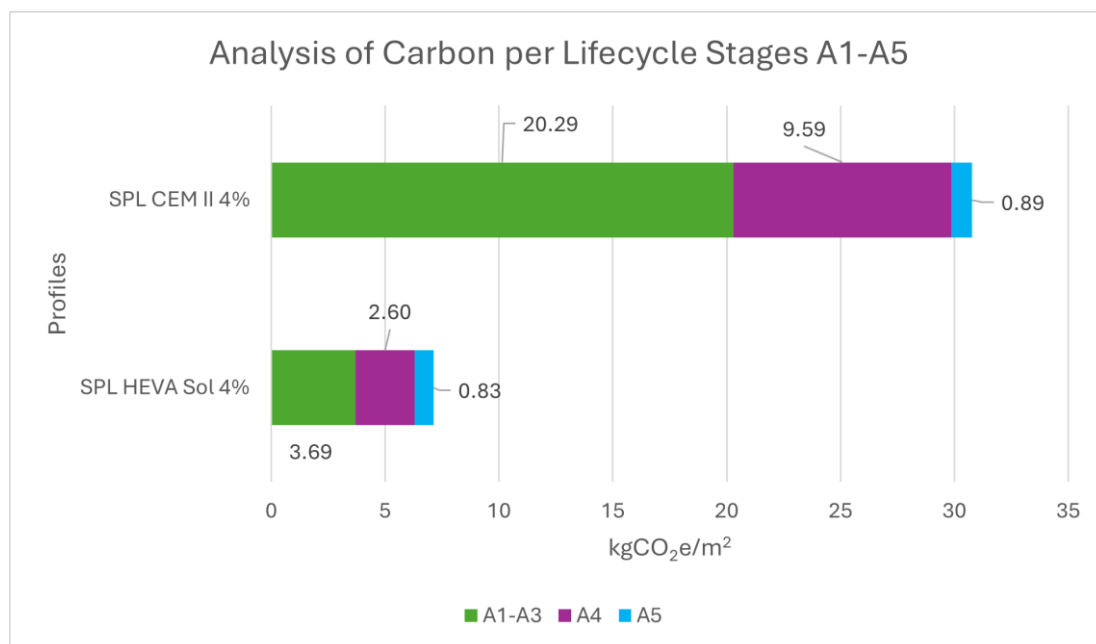


Figure 5: Carbon analysis of SPL in-situ recycling HEVA Sol 4% & CEM II 4% lifecycle stages A1-A3, A4, A5 per m²

Carbon analysis has included the activities involved with milling the existing surface and binder course of the carriageway as this is required to enable in-situ recycling to take place. The following analysis excludes these emissions to isolate the carbon impacts associated purely with the in-situ recycling process. Modelling is presented graphically in Figure 6 and Figure 7:

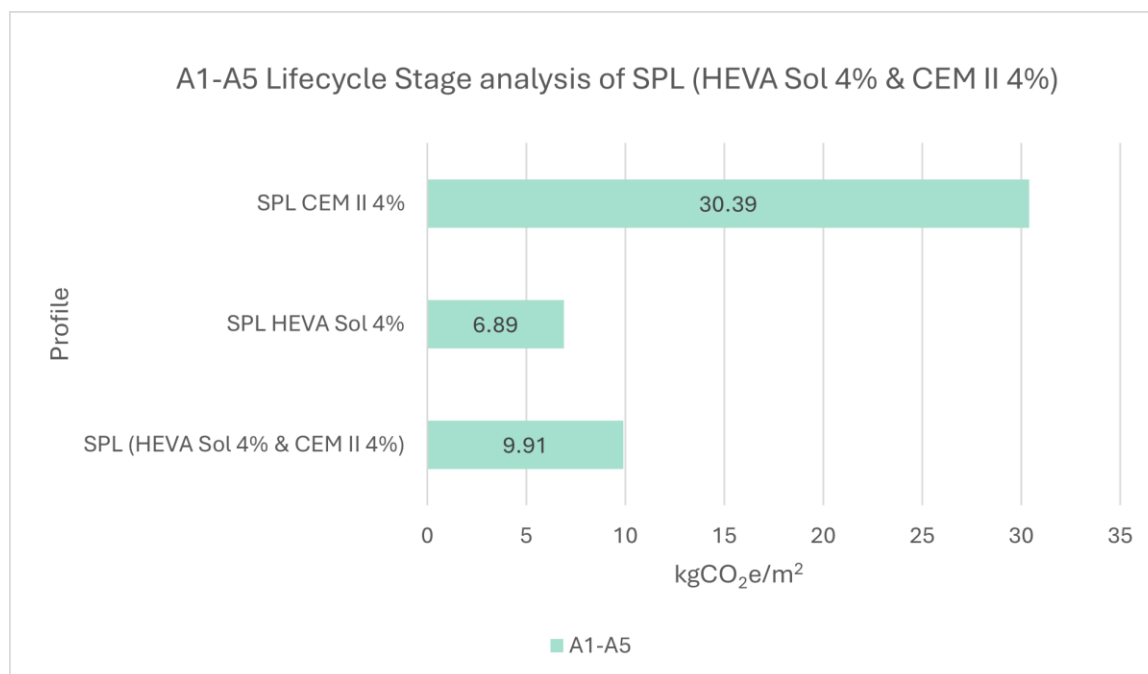


Figure 6: Carbon analysis of SPL in-situ recycling (no planing) Hirst Road, North Lanarkshire per m²

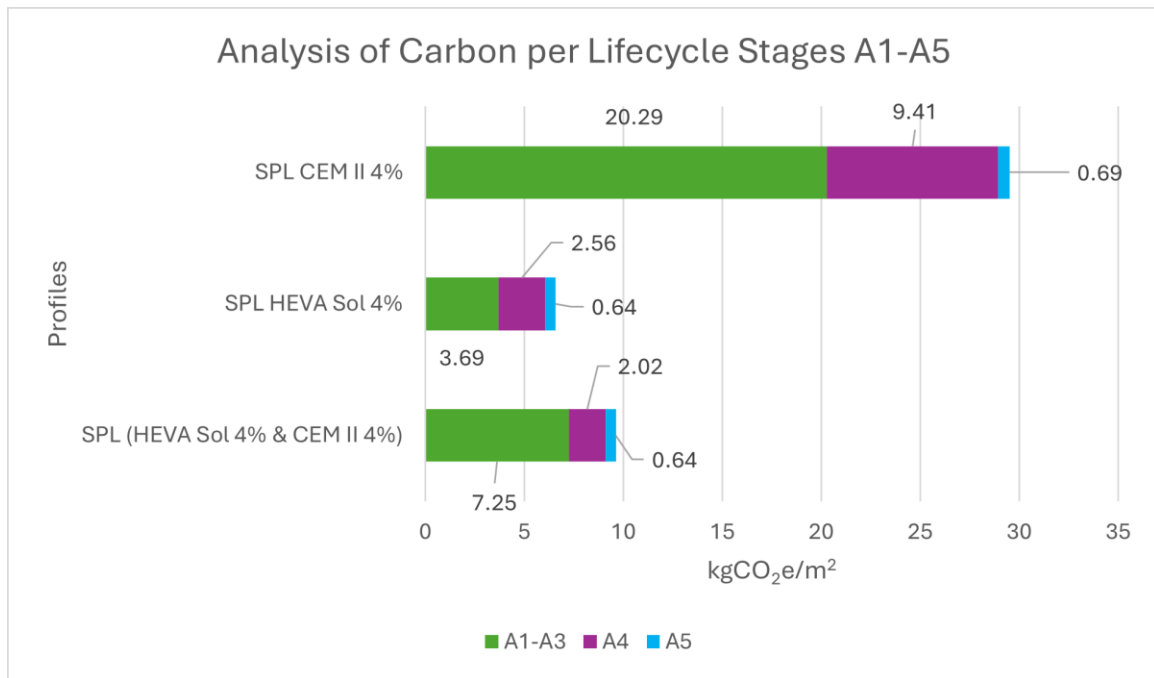


Figure 7: Carbon analysis of SPL in-situ recycling lifecycle stages A1-A3, A4, A5 (no planing) Hirst Road, North Lanarkshire per m²

Benchmarking

In-situ recycling was yet to be used in North Lanarkshire prior to this trial. These trials are to allow for an analysis of the performance of different types of in-situ recycling in comparison to conventional asphalt binder course replacement on the same road of the same traffic loads. This would be the traditional option for binder resurfacing if in-situ recycling was not used. This allows for comparisons between SPL's in-situ recycling methods versus BAU binder resurfacing within the carbon analysis.

The carbon analysis accounts for the planing of the original binder course, resurfacing of an AC20 binder course and the processing of the planings into Reclaimed Asphalt Pavement (RAP). Accounting for these activities provides a complete and conservative representation of construction stage emissions and any material substitution benefits. This ensures the appraisal captures both the additional operational burden of removal and the emissions associated with producing and re-using planings for RAP rather than employing in-situ recycling.

Comparative analysis results are presented graphically in Figure 8 and Figure 9:

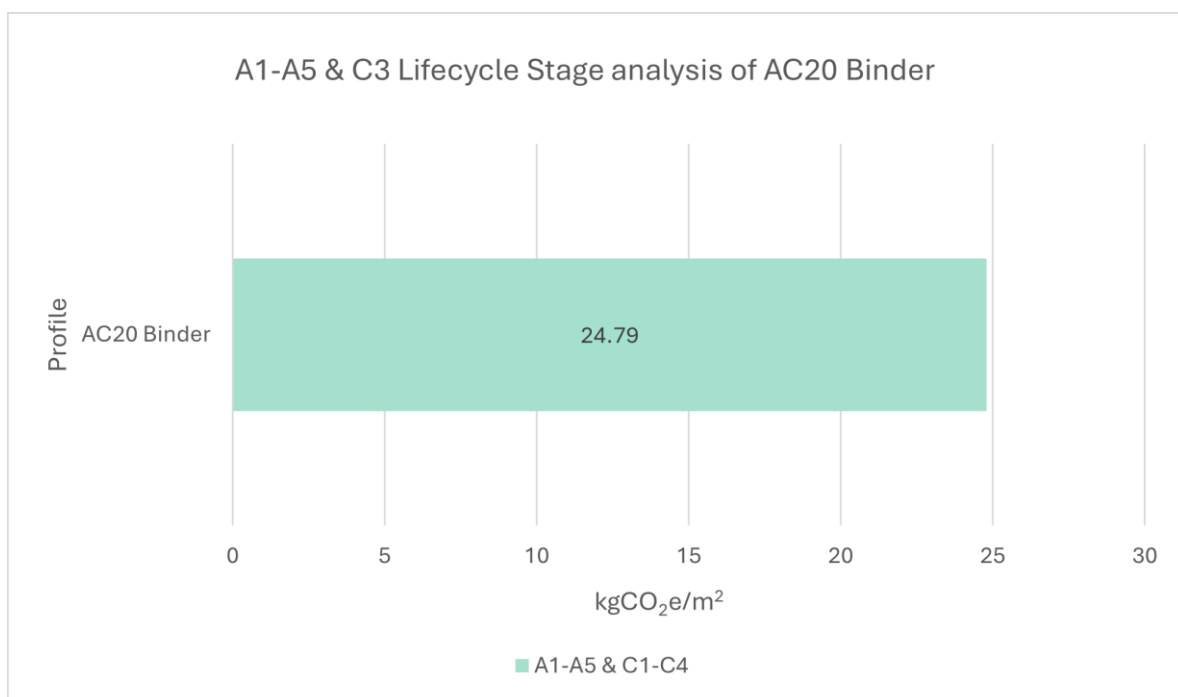


Figure 8: Carbon analysis of AC20 Binder lifecycle stages A1-A5 & C1-C4 per m²

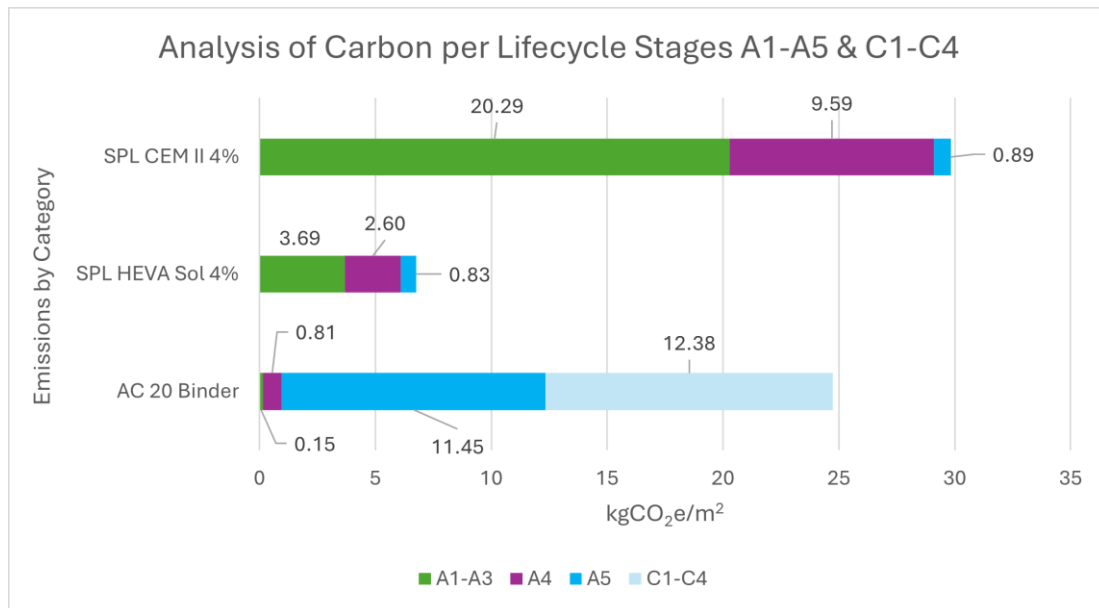


Figure 9: Comparative carbon analysis A1-A5 & C1-C4 per m²

A comparative analysis excluding transportation emissions was also performed to isolate the construction-stage benefits of in-situ recycling. This adjustment was necessary as SPL is not a local supplier and plant and personnel travelled long distances to complete the works, whereas planning and installation of an AC binder course represent business-as-usual (BAU) activities that can be delivered locally within North Lanarkshire.

Transportation can dominate A4 emissions when materials or specialist crews travel long distances; removing it from the comparison prevents those external logistics factors from obscuring the merits of in-situ recycling versus conventional resurfacing. Analysis removing transport emissions are presented graphically in Figure 10:

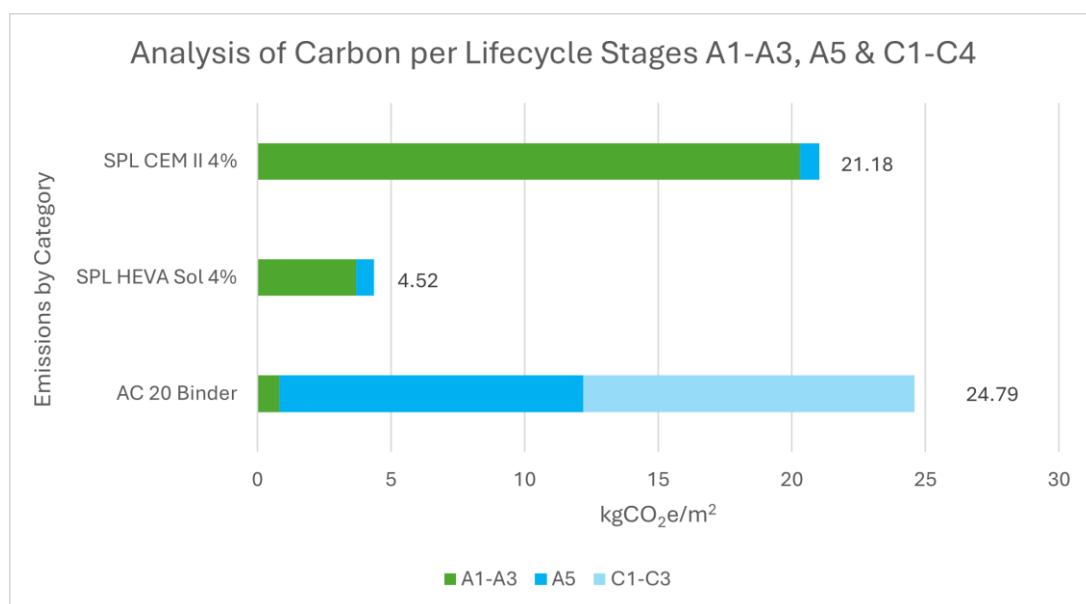


Figure 10: Comparative carbon analysis A4 values removed per m²

MATERIAL	COMPOSITION	APPLICATIONS	PERFORMANCE	INSTALLATION	SUSTAINABILITY
Asphalt binder course (AC20)	<p>This does not involve in-situ recycling. Instead the planings of the original binder and course are replaced</p> <p>Conventional AC20 binder course is composed of bitumen binder with a mixture of aggregates like stone, sand and gravel.</p> <p>The proportions of binder and aggregate differs depending on gradation and specification but is usually 5-7% binder by mass.</p>	<p>The conventional structural binder layer beneath surfacing on roads.</p> <p>Usually used beneath high-stress carriageways, motorways and urban roads.</p> <p>It suitable for most road types.</p>	<p>An AC20 binder course has high stiffness, high bearing capacity and is designed to resist permanent deformation and rutting under repeated axle loads when designed correctly.</p> <p>Has a long service life – typically designed for 20years plus.</p> <p>When surfaced with HRA, provides high skid resistance.</p>	<p>Produced at the asphalt plant and delivered to site hot in insulated trucks.</p> <p>Laid hot via asphalt paver and compacted by rollers. Maintaining a high temperature control is critical in ensuring correct installation.</p> <p>Requires high amount of traffic management, usually full or partial road closure.</p> <p>Has a limited laydown window for compaction and is weather sensitive, increasing the likelihood of waste.</p>	<p>High carbon emissions due to bitumen production and high temperature requirements during production and installation.</p> <p>Reclaimed asphalt pavement (RAP) can be incorporated.</p> <p>Has an established supply chain nationally that reduces transport emissions, and sourcing aggregates locally can further lower carbon emissions.</p> <p>Potential for the materials long design life to offset higher upfront carbon per year of service. However, only if maintenance is limited.</p>
HEVA- Sol	<p>HEVA-Sol 4% is a calcined clay emulsion binder which is mixed in-situ with the existing base layers, removed beforehand via planing. It binds to the milled carriageway allowing up to 100% recycling of the existing binder course.</p>	<p>In-situ recycling with HEVA-Sol is not suitable for all road types. Preferred road types are usually B and C roads in rural areas however this needs to be reassessed on a scheme-by-scheme basis.</p> <p>Bound into the original binder course layer for road rehabilitation.</p>	<p>The supplier claims that performance is on par with conventional binder course asphalt.</p> <p>Expected service life is to be typically 20 years.</p>	<p>Applied in-situ using a recycler followed by grader.</p> <p>Requires calibrated dosing, mixing and compaction but does allow for rapid return to service for the road.</p>	<p>The HEVA Sol binder contains 0% clinker, reducing the reliance on virgin material required in traditional cement production.</p>
CEM II 4%	<p>Portland composite cement (CEM II) added at 4% dosage to the existing binder layer, removed beforehand via planing. This is mixed in-situ. Conventional industry standard broadly used in road recycling and stabilisation.</p> <p>It binds to the milled carriageway allowing up to 100% recycling of the existing binder course.</p>	<p>The traditional binder for cold in-situ recycling, is bound into the original binder course layer for road rehabilitation.</p>	<p>The supplier claims that performance is on par with conventional binder course asphalt.</p> <p>Expected service life is to be typically 20 years.</p>	<p>Applied in-situ using a recycler followed by grader.</p> <p>Requires calibrated dosing, mixing and compaction but does allow for rapid return to service for the road.</p>	<p>CEM II is a virgin material, but versions do exist with recycled content.</p> <p>There is a risk we are simply replacing one high-carbon material (asphalt) with another (concrete).</p>

Table 4 SPL in-situ recycling Appraisal*

*All factors assessed as part of the appraisal of SPL in-situ recycling has been built on supplier provided material and are not drawn from the live trial.

Life Cycle Stage	Baseline Carbon Emissions (Asphalt Concrete Binder Course) (kgCO _{2e} /m ²)	HEVA-Sol 4% Carbon Emissions (kgCO _{2e} /m ²)	Difference from Baseline (%) (Increase/Reduction)
A1 – A3	0.15	3.69	2,360%
A4	0.81	2.60	221%
A5	11.45	0.83	93%
C1-C4	12.38	0	100%

Table 5: Lifecycle Stage Comparison to BAU

Life Cycle Stage	Baseline Carbon Emissions (Asphalt Concrete Binder Course) (kgCO _{2e} /m ²)	CEM II 4% Carbon Emissions (kgCO _{2e} /m ²)	Difference from Baseline (%) (Increase/Reduction)
A1 – A3	0.15	20.29	13,427%
A4	0.81	9.59	1,084%
A5	11.45	0.89	92%
C1-c4	12.38	0	100%

Table 6: Lifecycle Stage Comparison to BAU

Carbon Benefits and Considerations (Matrix)

Table 7 presents the findings of the carbon benefits and considerations matrix for SPL in-situ recycling. **All scoring is bold and underlined.**

Technical data used for the benchmark comparator were supplied by the manufacturer and are not derived from site trials. While reliance on supplier-provided information may introduce uncertainty in confidence levels, the information and data represent 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 - <u>Significant additional costs</u> 2 - Costs approximate baseline 3 - Costs significantly lower than baseline	HEVA-Sol 4% - Still relatively new to the UK market and therefore likely to have premium supply and import cost increases. However, removes the cost of removing waste from site and processing to RAP.
		1 - Significant additional costs 2 - <u>Costs approximate baseline</u> 3 - Costs significantly lower than baseline	CEM II 4% - Cementitious blends are available locally with modest cost uplift or parity to baseline.
Maintenance	Design life, maintenance burden, on-time for plant	1 – Significantly more maintenance/lower longevity 2- <u>Approximately same maintenance/similar longevity</u> 3 – Significantly less maintenance/higher longevity	HEVA-Sol 4% - Supplier claims durability equivalent to the baseline with a lifespan of 20 years.
		1 – Significantly more maintenance/lower longevity 2- <u>Approximately same maintenance/similar longevity</u> 3 – Significantly less maintenance/higher longevity	CEM II 4% - Supplier claims durability equivalent to the baseline with a lifespan of 20 years.
Scalability	Manufacturing facilities	1 - Lab testing only 2 - <u>In process of commercialisation w. small scale manufacture</u> 3 - Already has market presence with developed supply chain	HEVA-Sol 4% - Has presence on the UK market however only currently available for in-situ recycling with SPL.
		1 - Lab testing only 2 - In process of commercialisation w. small scale manufacture	CEM II 4% - Cement blends are widely produced within the UK and can be scaled through existing supply chains.

BENEFIT/LOAD UNDER REVIEW	CONSIDERATIONS	SCORING SYSTEM	JUSTIFICATION
Compliance with specifications	Requirements for standards departures	<p>3 - Already has market presence with developed supply chain</p> <p>1 - Requires significant departure(s) from standard and has not been used before by end client</p> <p>2 - Requires some departure from standard, but has been used before by end client</p> <p>3- Already has market presence with developed supply chain</p>	<p>HEVA-Sol 4%- No major departures reported within the trial. However, further long-term monitoring is required.</p>
		<p>1 - Requires significant departure(s) from standard and has not been used before by end client</p> <p>2 - Requires some departure from standard, but has been used before by end client</p> <p>3- Already has market presence with developed supply chain</p>	<p>CEM II 4% - CEM II variants typically conform to existing specs.</p>
Environmental	Nature-based solution	<p>1 - Would have significant net disbenefit for environmental factors (noise, AQ, biodiversity, landscape etc)</p> <p>2 - Would have negligible net benefit/disbenefit or no overall change regarding environmental factors</p> <p>3 - Would have significant net benefit/disbenefit for environmental factors.</p>	<p>HEVA-Sol 4%- In-situ recycling produces volumes of dust which has potential to effect local biodiversity and therefore is not suitable for areas designated for protected species and habitats as works may result in disturbance.</p>
		<p>1 - Would have significant net disbenefit for environmental factors (noise, AQ, biodiversity, landscape etc)</p> <p>2 - Would have negligible net benefit/disbenefit or no overall change regarding environmental factors</p> <p>3 - Would have significant net benefit/disbenefit for environmental factors.</p>	<p>CEM II 4% - In-situ recycling produces volumes of dust which has potential to affect local biodiversity and therefore is not suitable for areas designated for protected species and habitats as works may result in disturbance.</p>

BENEFIT/LOAD UNDER REVIEW	CONSIDERATIONS	SCORING SYSTEM	JUSTIFICATION
	Road noise	<p>1 - Would have significant net disbenefit</p> <p>2 - Would have negligible net benefit/disbenefit or no overall change regarding</p> <p>3 - Would have a significant net benefit</p>	<p>HEVA-Sol 4%- No expected change to noise characteristics versus the benchmark.</p>
		<p>1 - Would have significant net disbenefit</p> <p>2 - Would have negligible net benefit/disbenefit or no overall change regarding</p> <p>3 - Would have a significant net benefit</p>	<p>CEM II 4% - No expected change to noise characteristics versus the benchmark.</p>
	Climate resilience/future proofing	<p>1 - Would have significant net disbenefit</p> <p>2 - Would have negligible net benefit/disbenefit or no overall change regarding</p> <p>3 - Would have a significant net benefit</p>	<p>HEVA-Sol 4%- Reusing the existing surface reduces the reliance on virgin materials in road construction.</p> <p>The calcined clay binder contains 0% clinker with suppliers claiming a carbon footprint that is 4 times smaller than traditional cement and reducing reliance on virgin materials.</p>
		<p>1 - Would have significant net disbenefit</p> <p>2 - Would have negligible net benefit/disbenefit or no overall change regarding</p> <p>3 - Would have a significant net benefit</p>	<p>CEM II 4% - Reusing the existing surface reduces the reliance on virgin materials in road construction.</p> <p>However, CEM II remains a virgin material, so there is a risk we are merely replacing one high-carbon material (asphalt) with another (concrete).</p>
Risk and safety	H&S impacts, safety testing data	<p>1 - Would present increased risk or safety versus BAU option</p> <p>2 - Would present no overall risk increase or safety impact versus BAU option</p> <p>3 - Would present lower risk or safety impact versus BAU option.</p>	<p>HEVA-Sol 4%- In-situ recycling requires the use of a Recycler, which is not required in conventional asphalt laying. However, if all H&S controls are taken, no additional safety risks beyond the BAU are expected.</p>
		<p>1 - Would present increased risk or safety versus BAU option</p> <p>2 - Would present no overall risk increase or safety impact versus BAU option</p> <p>3 - Would present lower risk or safety impact versus BAU option.</p>	<p>CEM II 4% - In-situ recycling requires the use of a Recycler, which is not required in conventional asphalt laying. However, if all H&S controls are taken, no additional safety risks beyond the BAU are expected.</p>
		<p>1 - Not yet commercially available</p>	<p>HEVA-Sol 4%- Readily available from local suppliers and established in the UK market.</p>

BENEFIT/LOAD UNDER REVIEW	CONSIDERATIONS	SCORING SYSTEM	JUSTIFICATION
Technology Readiness Level	Is it commercially available, is there enough R&D?	2 - Commercially available from worldwide suppliers 3 - Commercially available from European suppliers 4 - Commercially available from UK suppliers 5 - Commercially available from local suppliers	
		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	CEM II 4% - Readily available from local suppliers and established in the UK market.
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	HEVA-Sol 4% - Installed using a Recycler, this requires specialist training. However, after recycling installation follows typical grading and rolling procedures.
		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	CEM II 4% - Installed using a Recycler, this requires specialist training. However, after recycling installation follows typical grading and rolling procedures.
Supply Chain	Material availability	1 - Novel materials used with limited supply 2 - Materials are available with some supply restrictions 3 - Materials are readily available	HEVA-Sol 4% - Materials are available within the UK however not readily available and therefore require ordering in advance and can be impacted by shipping delays.
		1 - Novel materials used with limited supply 2 - Materials are available with some supply restrictions	CEM II 4% - CEM II is readily available in the UK and readily purchasable.

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	HEVA-Sol 4% - Recycling uses up to 100% of the existing pavement and reduces virgin material use. However, the calcined clay does not contain any recycled materials.
		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	CEM II 4% - Recycling uses up to 100% of the existing pavement and reduces virgin material use. While the recycled content of the CEM II binder in this trial is unknown. Recycled content within CEM II can include industrial by-products within its composition.
	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	HEVA-Sol 4% - Recycling pathways may require validation. Additional processing steps may be required. More research is required on final recyclability behaviour and at what point in-situ recycling is no longer a viable option.
		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	CEM II 4% - Cementitious mixes are generally compatible with existing RAP processes. Additional processing steps may be required. More research is required on final recyclability behaviour and at what point in-situ recycling is no longer a viable option.

Table 7: Carbon benefits and considerations matrix

Long-Term Performance Analysis

The carbon analysis within this report does not include a 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 Re-recycling Intervals.

Conclusion & Recommendations

Conclusions

The live trial of materials HEVA-Sol 4% and CEM II 4% and SPL's in-situ recycling method has demonstrated some promising results for sustainable road surfacing practices when compared to conventional binder course removal and replacement. The trial results show that in-situ recycling can lower lifecycle stage A1-A5 emissions. The most notable savings have been experienced when using HEVA Sol as a binder, this achieved a 71.28% reduction in carbon emissions relative to the baseline binder course reconstruction process and delivering the lowest carbon emissions at 7.12 kgCO₂e/m².

The process of in-situ recycling showed operational benefits, including reduced transport demand and reduced reliance on virgin materials. These advantages support the wider objectives of Live Labs 2 by providing evidence that cold, in-situ techniques can play an important role in future decarbonisation strategies for local authorities.

It is noted that SPL have also demonstrated a commitment to reducing carbon emissions in road maintenance. This includes the use of hybrid vans and rollers during construction and the option to use hydrotreated vegetable oil (HVO) fuel for plant². HVO fuel is a second-generation oil manufactured from waste oils, fats and certified residues. The use of this fuel has the potential to further reduce carbon emissions. Carbon modelling replacing conventional diesel with hydrotreated vegetable oil (HVO) demonstrated a potential additional reduction of 1% for CEM II 4% and 10% for HEVA-Sol 4%.

The trial also identified several uncertainties that should be addressed before widescale adoption can be recommended. In particular, the variability of transportation emissions associated with SPL's current supply chain and operational footprint. This is of particular consideration as the in-situ recycling process requires specialist expertise and plant that cannot yet be sourced locally. Furthermore, CEM II 4% demonstrated substantially higher A1-A5 lifecycle stage emissions in comparison to HEVA Sol. While still providing reduction relative to the baseline (given A4 lifecycle stage emissions are removed), caution is required given its reliance on highly virgin cementitious material.

Overall, the live trial has demonstrated that SPL's in-situ recycling is a viable, lower carbon alternative to conventional binder replacement and has potential to support Local Authority decarbonisation programmes, provided further validation of HEVA Sol's EPD and long-term monitoring is undertaken.

² <https://lcrig.org.uk/wp-content/uploads/2024/11/SPL.pdf>

Recommendations

It is recommended that robust long-term monitoring (over 5+ years) be implemented at treated sites to comprehensively evaluate performance and verify lifecycle carbon savings. This further long-term monitoring will allow for more expansive carbon modelling to assess end-of-life scenarios to provide a more comprehensive understanding of whole life carbon emissions.

North Lanarkshire should consider adopting in-situ recycling in targeted maintenance programmes, beginning with sites similar to those trialled. This should be subject to the confirmation of long-term performance and be focussed on HEVA Sol in particular for B and C class rural roads where sustainability benefits can be maximised without compromising road function. The adoption of in-situ recycling using HEVA-Sol would place North Lanarkshire in a stronger position to achieve its net-zero commitments.

Should this be adopted, training for NLC operational teams would be recommended. This would involve the investment in training programmes for the NLC contractors to enable broader deployment of SPL in-situ recycling while lowering transport related emissions which are currently a significant contributor to overall carbon emissions.

An area for further investigation is the long-term recyclability of in-situ recycling layers. The process allows for all the existing binder course to be reused during installation however; it remains unclear at what point in-situ recycling of the existing carriageway is no longer achievable and what the end-of-life pathways for these treated layers would be. This includes determining whether in-situ recycled asphalt can be incorporated into Reclaimed Asphalt Pavement (RAP), whether additional processing would be necessary and whether repeat in-situ recycling is feasible. Clarifying this will help to validate long-term circularity.