



Department for Transport

ADEPT **LIVELABS2**
Decarbonising Local Roads



**LIVERPOOL
LIVE LABS**
DRIVING DECARBONISATION

LIVERPOOL LIVELABS

CASE STUDIES

These case studies highlight the extensive scope of collaboration with a goal to create a framework for decarbonising local roads in the UK in order to achieve net zero by 2030.



LIVERPOOL LIVELABS

CASE STUDIES

DRAINAGE & PERMEABILITY

Reducing Embodied Carbon Through Sustainable Drainage & Permeable Systems

This Drainage & Permeability case study forms part of a wider suite of case studies capturing the findings from the Liverpool Live Labs programme and reflects the city's commitment to decarbonising highway infrastructure.

Live Labs 2 is a three-year, £30 million UK-wide programme funded by the Department for Transport, running until March 2026 and followed by a five-year extended monitoring and evaluation period.



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FOREWORD

The ADEPT Live Labs 2: Liverpool programme has been an enriching learning experience for Liverpool City Council, our highways teams, our communities, and the many SMEs that form the backbone of our local innovation ecosystem. Decarbonisation sits at the core of long-term resilience, and with Liverpool's ambitious goal of becoming a net zero city by 2030, this programme has played a critical role in accelerating our progress, alongside our wider evolution as a Council.

Through Live Labs 2, Liverpool is now equipped with a cohort of professionals who are familiar with a nationally accepted carbon assessment and capture methodology – giving us the tools, understanding and confidence to make informed, accountable decisions about carbon reduction across the lifecycle of our highways assets. This capability will long outlast the programme itself, embedding a legacy of informed, data-driven decarbonisation in the city's operations where these have been proved by the programme.

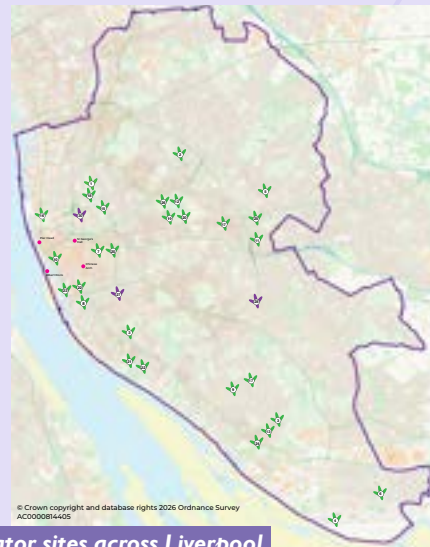
Within the programme ecosystem, we tested **26 innovations**, spanning far more than materials alone. These included new processes, toolkits, decision-making approaches, and practical interventions that collectively support our commitment to building a functioning highways decarbonisation ecosystem. Supported by an expert panel, each option was rigorously assessed for its innovation potential and its ability to meaningfully reduce carbon before being adopted. Our ambition from the outset was clear: embrace innovation, remain open to challenge, and work collaboratively to understand what truly moves the needle on carbon reduction.

Despite needing to align with wider changes within the Council, and the challenges faced by nearly all Authority's across the UK, the programme succeeded because of the strength, expertise, and dedication of our partners across the ecosystem. We would like to extend our sincere thanks to the core members of the innovation ecosystem developed through the programme:

- **Colas** – Programme Delivery & Innovation Management Partner, also realising new ways of including carbon impacts into road condition-based Asset Management approaches.
- **Bird & Bird** – Co-developer of a pioneering procurement toolkit.
- **Pell Frischmann** – Developers of the Options Configurator Tool.
- **Proving Services** – Independent testers of our assumptions and carbon assessment approaches.
- **Liverpool John Moores University** – Innovators in materials development.
- **Dowhigh and Huyton Asphalt Civils** – Our committed local contractors installing innovation products and embracing new ways of working.
- **Newcastle City Council and Aberdeen City Council** - Partner cities for demonstrators and vital knowledge sharing.

Another defining strength of the programme was its verge-to-verge scope. This was not limited to resurfacing or traditional asset management innovations. We trialled solutions in road marking, drainage, reuse and recycling, operational processes, and more – reflecting the full complexity and opportunity of the road environment.

From the 26 innovations we trialled, 17 innovations spanning categories such as Decision-Making & Network Management, Road Markings, Intelligent Lighting, Asset Maintenance, Drainage, and People-Focused Street Enhancements have already been adopted or are moving toward becoming business-as-usual, provided the site conditions are suitable. Others are undergoing extended monitoring and evaluation over the next five years to better understand performance, durability, and long-term carbon reduction potential. And while not every innovation delivered the outcomes we hoped for, each trial provided valuable learning - an essential part of any genuine innovation journey.



Demonstrator sites across Liverpool

As we present this suite of case studies, we do so with pride in what can be achieved with a laser-sharp focus, unwavering dedication and a culture of collaboration. These pages represent countless hours of collaboration, problem-solving, curiosity, and shared ambition across partners, teams, and communities.

On behalf of Liverpool City Council, I would like to extend our sincere thanks to the Department for Transport (DfT) and ADEPT as the funding and commissioning bodies, whose support and leadership have been essential in enabling this work. I would also like to thank every partner, every member of our LCC teams, every contractor, SME, academic, and every community voice – big or small – who contributed to the success of this project. Your effort and commitment have not only delivered a highly successful programme but have also helped build the foundations for a cleaner, more resilient, and more sustainable Liverpool.



Director of Sustainable Transport,
Highways and Parking,
Liverpool City Council





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CASE STUDY DRAINAGE & PERMEABILITY

Reducing Embodied Carbon Through Sustainable Drainage & Permeable Systems

I. Executive Summary

The Drainage & Permeability category explores sustainable drainage and permeable surface technologies trialled in Liverpool where the primary driver for deployment was measurable carbon reduction compared to conventional Business-As-Usual (BAU) drainage and impermeable surfacing systems. The innovations explored in this category are Kiacrete, KBI Flexipave and Rosehill Modular Drainage system. Liverpool experiences high rainfall, sits on the Mersey Estuary, and contains ageing drainage infrastructure. These factors increase surface-water flood risk with strategic flood risk studies from the Liverpool City Region showing the need for improved measures to manage surface water run-off. The Council is keen to explore how different permeable pavements can allow water to soak naturally into the ground, especially during extreme weather events driven by climate change.

The combination of high rainfall, climate-driven changes, flood-prone geography, and ageing drainage systems means that expanding permeable surfaces and SuDS is necessary. It is expected that permeable drainage will help Liverpool:

- reduce surface-water flood risk
- take pressure off sewer systems

- improve water quality
- increase climate resilience
- enhance green urban spaces

There are a number of high-risk clusters of localised flooding reported for neighbourhoods across Liverpool. Where possible, interventions have been targeted within these clusters.

Traditional drainage infrastructure often relies on:

- Impermeable surfacing
- Extensive pipe networks
- Deep excavation
- Concrete chambers
- High embodied carbon materials

In addition to carbon intensity, conventional systems increase surface runoff, placing pressure on sewer networks and increasing flood risk.

Each innovation within this category was independently assessed against its BAU comparator to evaluate:

- Embodied carbon savings
- Whole-life performance
- Stormwater management benefits
- Suitability for wider adoption



CASE STUDY DRAINAGE & PERMEABILITY

Reducing Embodied Carbon Through Sustainable Drainage & Permeable Systems

2. Business-As-Usual (BAU) Baseline

The typical BAU drainage solutions used as baseline scenarios include:

- Impermeable asphalt surfacing (Upper Pitt Street)
- Precast concrete drainage infrastructure, including drainage channels and permeable block paving (Castletown Close, Newsham Park, and Thomas Lane).
- Cast iron channel grating (Castletown Close and Thomas Lane)

The most significant carbon impacts are attributable to:

- High concrete content
- Cast iron channel grating
- Hot asphalt
- Deep excavation and plant use
- Transportation of materials
- Maintenance and replacement cycles (particularly for asphalt compared to concrete)

Additionally, BAU systems often increase peak runoff rates, contributing to downstream infrastructure pressure.

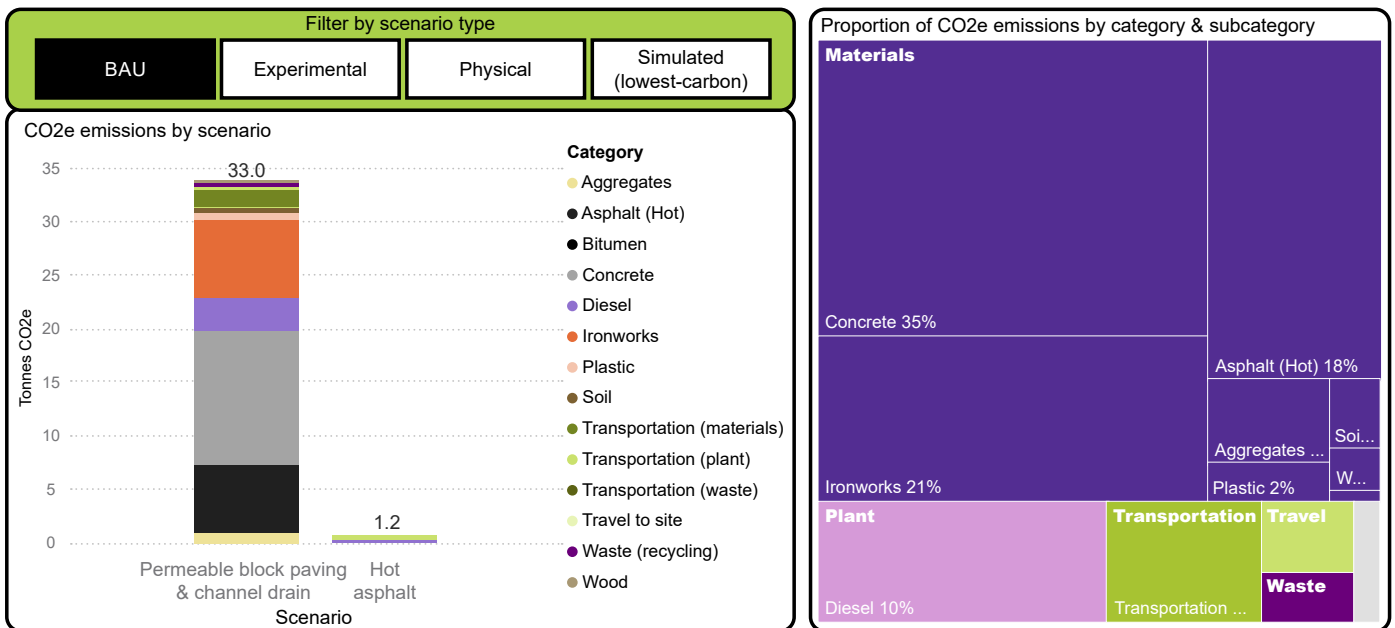


Figure 1: Breakdown of carbon impacts for the BAU baselines for Castletown Close, Newsham Park, and Thomas Lane (permeable block paving and channel drain) and Upper Pitt Street (hot asphalt)

CASE STUDY DRAINAGE & PERMEABILITY

Reducing Embodied Carbon Through Sustainable Drainage & Permeable Systems

3. Innovation Funnel & Advisory Panel

To support consistent, transparent and evidence-based decision-making across the programme, an Expert Advisory Panel was established to guide the evaluation and selection of all innovations considered for Live Labs trials. The panel brings together specialists from local authorities, academia, engineering, behavioural insights, lighting, and innovation management, providing a balanced and multidisciplinary review of each proposed solution. Working alongside the scoring workshop, the panel

independently assesses technical feasibility, safety benefits, carbon impact, operational risks, installation constraints and long-term sustainability. Through structured scoring, expert discussion and refinement, the panel ensures that only the most suitable, high-value technologies progress to the planning and implementation stages. This process has been instrumental in ensuring that all chosen innovations are robust, appropriate for local conditions, and aligned with the overarching objectives of safety, decarbonisation and improved user outcomes.

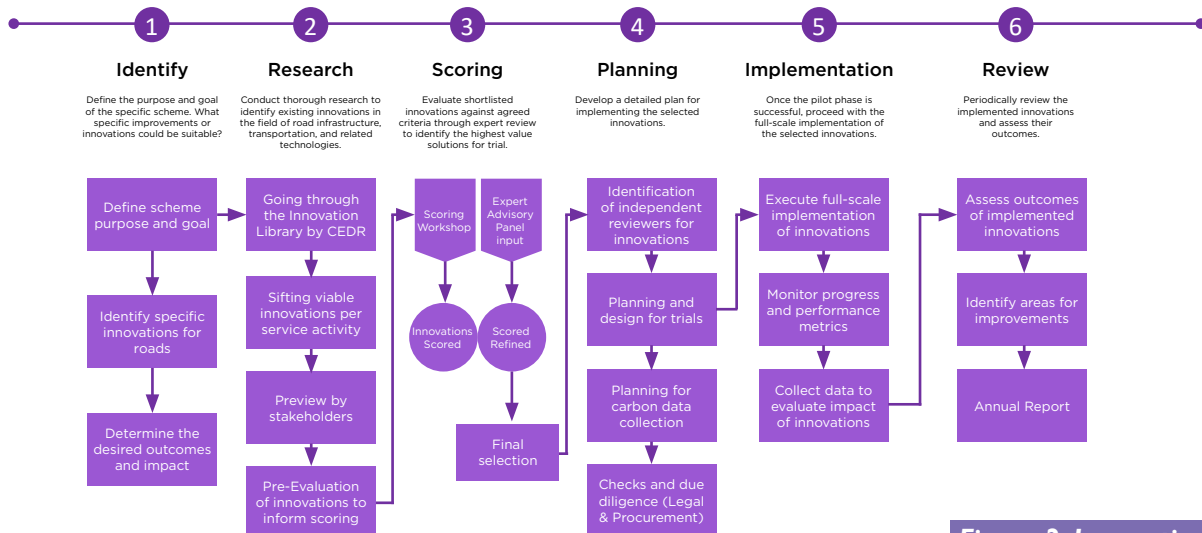


Figure 2: Innovation Funnel

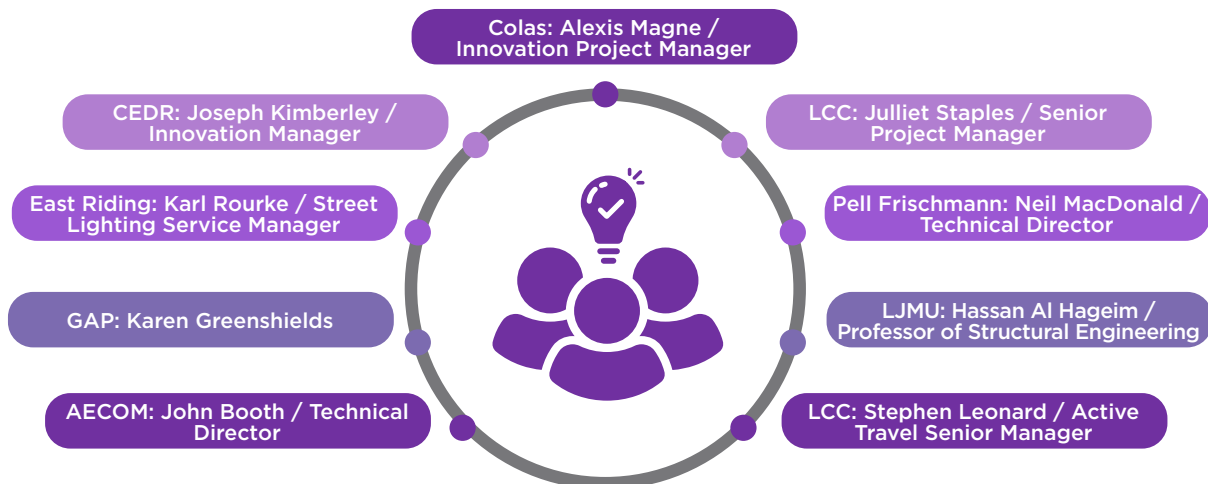


Figure 3: Expert Panel

CASE STUDY DRAINAGE & PERMEABILITY

Reducing Embodied Carbon Through Sustainable Drainage & Permeable Systems

4. Carbon Assessment Methodology

Each innovation was assessed against its BAU comparator using whole-life carbon principles, in accordance with the Carbon Calculation and Accounting Standard (CCAS) process (as outlined in Figure 4) and the PAS2080 carbon lifecycle stages.

Carbon calculations considered:

- The embodied carbon of the materials used
- Transportation and travel to site
- Installation processes and plant use
- Operational energy requirements (where applicable)
- The processing of waste removed from site
- Maintenance frequency
- Expected lifespan

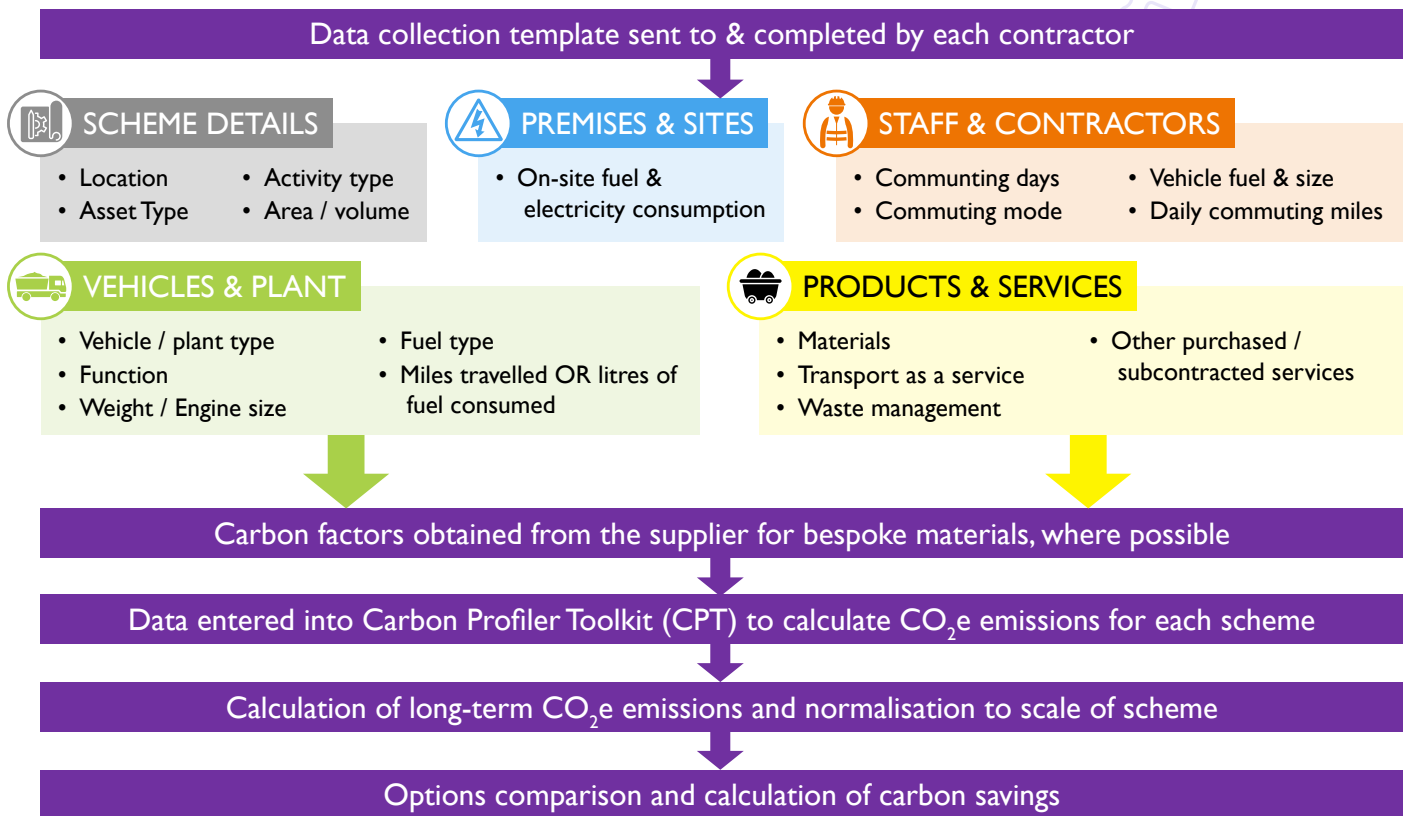


Figure 4: The carbon assessment process

Percentage reductions stated in the Carbon Impact section of each case study reflect the difference in carbon emissions between the innovation and its conventional equivalent.

CASE STUDY DRAINAGE & PERMEABILITY

Reducing Embodied Carbon Through Sustainable Drainage & Permeable Systems

5. KIACRETE: PERMEABLE PAVEMENT

Type: Permeable pavement

Primary Driver: Stormwater infiltration + drainage infrastructure reduction

Carbon Saving: 3.7 tCO₂e (61%) over 40 years

Live Labs Deployment: Upper Pitt Street - connected to Catherine Square/Street cycle link

Installed on site by: A E Yates

5.1 Innovation Description

Kiacrete is an engineered permeable concrete pavement system designed to deliver ultra-high infiltration, enabling stormwater to drain directly into the ground rather than into the piped network. The technology incorporates dedicated vertical drainage channels that allow water to bypass the surface layer and infiltrate the subbase and subgrade.

Kiacrete differs from conventional permeable pavements through:

- Permeability up to 5 cm/s, significantly higher than typical permeable asphalt or concrete.
- Resistance to clogging, maintaining stable permeability even after 13 accelerated clogging cycles.
- Superior durability, including resistance to freeze-thaw damage over 56 test cycles with no mass loss.
- High structural strength (19-59 MPa), supporting a wider range of applications including heavy-load environments.

These characteristics make Kiacrete a robust option for sustainable drainage in urban areas, particularly where traditional permeable systems fail due to clogging, degradation, or maintenance burdens.



Figure 5: Ariel view of Kiacrete at Upper Pitt Street

5.2 BAU Comparator

The BAU system used for comparison is a traditional impermeable pavement system, consisting of:

- Impermeable asphalt
- Sub-surface piped drainage network
- Concrete chambers and gullies
- Deep excavation and associated embodied carbon



Figure 6: Kiacrete Surface

CASE STUDY DRAINAGE & PERMEABILITY

Reducing Embodied Carbon Through Sustainable Drainage & Permeable Systems

5.3 Site Selection

Kiacrete was selected for trial on Upper Pitt street, as not only is the Toxteth area included as a high risk localised flooding area, this particular link is on a heavily trafficked active travel route chosen due to:

- Regular surface water accumulation on the existing pavement network.
- Need for rapid drainage performance for cyclists.
- Opportunity to integrate with Permavoid geocellular storage tanks for hybrid drainage performance (48 precast slabs laid over 150 mm Permavoid units).
- Public-facing location ideal for demonstrating the benefits of permeable technology within active travel infrastructure.

The site allowed the team to test precast Kiacrete units, a newer modular version designed for fast installation and factory-controlled quality.

Of note, Upper Pitt Street is a key connector to the Baltic Triangle Area of Liverpool and the Ropewalks District. In close vicinity to both Universities, the Cathedrals and key shopping areas, this site offered a prominent location to test this innovation, in a location which would have wider community benefits in connecting to the Route 6 (Connects the southern

suburbs to the university area and city centre) and Route 7 (Provides a dedicated, safer route along the eastern corridor into the city centre) for active travel.

5.4 Hypothesis

Implementing Kiacrete was expected to deliver the following:

1. Reduced embodied carbon
 - a. Lower cement use due to engineered pore structure (approx. 10-11.6% reduction).
 - b. Longer service life (40 years vs. 7-10 years for asphalt / permeable asphalt).
2. Reduced local flooding
 - a. Immediate infiltration through high-permeability channels.
3. Drainage infrastructure avoidance
 - a. Reduced requirement for gullies, chambers, and piped systems, cutting both cost and embodied carbon.
4. Improved user safety
 - a. Removal of puddles to reduce splash, spray, and skidding risks - critical on cycleways.

Figure 7: Kiacrete at Upper Pitt Street



CASE STUDY DRAINAGE & PERMEABILITY

Reducing Embodied Carbon Through Sustainable Drainage & Permeable Systems

5.5 Carbon Impact

- 2.4 tCO₂e upfront emissions
- 3.8 tCO₂e saving over 40 years
- 62% reduction over 40 years
- Potential carbon reduction of up to 28% (86% over 40 years) with low-carbon concrete and HVO

Carbon reductions are primarily derived from:

- Reduced concrete and pipe infrastructure
- Lower excavation requirements
- Avoidance of extensive drainage network components

Whole-life modelling over 40 years demonstrates significant infrastructure avoidance benefit.



Figure 8: Carbon profiles (top) and 40-year carbon profiles (bottom) for KiaCrete scheme on Upper Pitt Street



CASE STUDY DRAINAGE & PERMEABILITY

Reducing Embodied Carbon Through Sustainable Drainage & Permeable Systems

5.6 Wider Benefits

Stormwater Management Benefits

- Up to 10x more permeable than conventional permeable pavements.
- Rapid infiltration reduces peak runoff and surface water pooling.
- Helps mitigate urban flooding, which is projected to worsen due to climate change.

Climate Resilience

- Resists clogging and freeze–thaw degradation, ensuring drainage performance over decades.
- Reduces urban heat island effect by reflecting solar radiation and absorbing runoff.

Environmental Benefits

- Can capture 1,163 L/m²/year of rainwater for reuse or groundwater recharge.
- Reduced embodied carbon through:
 - Lower cement content
 - Lower material volumes
 - 40-year design life reducing renewal cycles

5.7 Monitoring

Performance monitoring from Kiacrete demonstration sites show:

- Stable permeability over 12 months despite heavy clogging exposure.
- No observed puddling or surface flooding, even during severe rainfall, or snowy weather, compared with adjacent conventional pavements.
- Precast slabs demonstrated 90% of the load-bearing capacity of solid slabs, validating their performance under cycling traffic.

5.8 Learning and Outcomes

The Kiacrete deployment reinforced several key insights:

1. Infrastructure avoidance delivers major carbon savings

Eliminating or reducing piped drainage provides a substantial portion of the 62% carbon reduction achieved in the whole-life model.

2. Ground conditions are critical

Kiacrete performs best where infiltration is possible or where integrated storage systems (e.g., Permavoid) can be incorporated.

3. Durability reduces whole-life carbon

A 40-year service life significantly outperforms BAU systems that require replacement every 7-10 years.

4. High permeability improves safety and resilience

The system mitigates puddling, reduces skidding risk, and enhances resilience against intense storms.



REDUCING
EMBODIED
CARBON

CASE STUDY DRAINAGE & PERMEABILITY

Reducing Embodied Carbon Through Sustainable Drainage & Permeable Systems

6. KBI FLEXIPAVE: PERMEABLE FOOTWAY SURFACING

Type: Permeable footway surfacing

Primary Driver: Recycled material substitution

Carbon Saving: 6.2 tCO₂e (24%)

Live Labs Deployment: Footway installation at Thomas Lane, Liverpool

Installed on site by: Dowhigh Ltd and KBI as specialist contractor

6.1 Innovation Description

KBI Flexipave is a highly porous, flexible paving system manufactured from a blend of recycled rubber granules (derived from end-of-life vehicle tyres) and natural stone aggregate, bound together with a unique polyurethane binder.

The material is mixed on site and installed by hand, allowing the system to be adapted to a wide variety of surface types and performance requirements.

Key performance characteristics include:

- High porosity, allowing large volumes of water and air to permeate directly through the surface.
- Dynamic flexibility, enabling the pavement to accommodate movement, temperature changes, and settlement without cracking.
- Compatibility with simple stone sub-bases, reducing the need for engineered layers and lowering embodied carbon.
- Use of recycled materials, particularly shredded tyre rubber.

The system is designed to promote direct infiltration and natural groundwater recharge, providing an alternative to impermeable footway surfacing such as asphalt or concrete.



Figure 9: KBI Flexipave at Thomas Lane

6.2 BAU Comparator

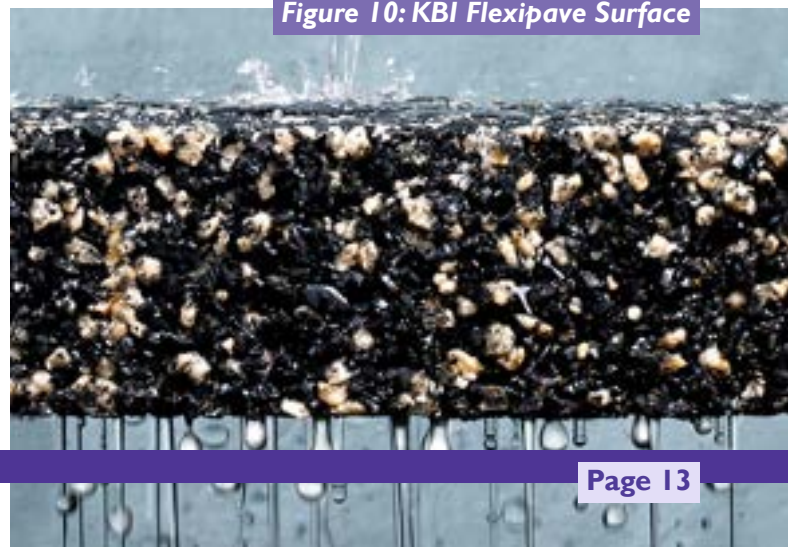
The BAU system for comparison is a conventional impermeable footway surface, typically comprising:

- Asphalt surfacing
- Impermeable sub-layers
- Collection via gullies and piped drainage
- Larger excavations and engineered build-up layers

BAU surfacing generates high runoff, contributes to localised flooding, and does not incorporate recycled materials.

Flexipave offers an alternative by reducing runoff and enabling recycled content substitution.

Figure 10: KBI Flexipave Surface



CASE STUDY DRAINAGE & PERMEABILITY

Reducing Embodied Carbon Through Sustainable Drainage & Permeable Systems

6.3 Site Selection

Thomas Lane links to multiple important local routes, including:

- East Prescott Road (A57)
- Bowring Park Road (A5080)
- Rocky Lane
- Thingwall Avenue
- Old Thomas Lane

These connections position it as a significant local connector between key districts such as Broadgreen, Old Swan, and Knotty Ash. Providing key walking access to Broadgreen Hospital, Alder Hey Hospital and to local the local station, schools, shopping and housing development, good walking routes are important.

Thomas Lane was selected as a Live Labs trial site due to:

- Documented surface water accumulation and poor drainage performance on existing footways
- The location providing a suitable setting to evaluate a permeable surfacing solution within a pedestrian-intensive environment, driven by foot traffic associated with adjacent schools and healthcare facilities.
- Suitability for deploying Flexipave over a simple compacted stone sub-base, removing the need for deeper excavation or engineered layers
- Desire to trial a recycled-content pavement aligned with Liverpool City Region's circular economy objectives
- Thomas Lane's elevation ranges from 33.7m to 46.1m, with multiple height points across its length. This is a substantial elevation spread for a single suburban street. In general, roads with such variation can develop natural low-lying sections, which may accumulate water during heavy rainfall.

The site provided a controlled environment to observe how Flexipave performs in an urban footway setting with typical pedestrian wear, shaded sections, and daily rainfall exposure.

6.4 Hypothesis

The Live Labs team anticipated that Flexipave would deliver the following benefits:

1. Reduced embodied carbon

Primarily achieved through the use of recycled tyre rubber in place of virgin aggregates and through avoiding engineered sub-base layers thanks to its adaptable installation requirements.

2. Improved infiltration performance

High porosity would reduce surface water pooling and minimise load on existing drainage.

3. Enhanced durability and crack resistance

The dynamic flexibility of the PU-bound rubber matrix would eliminate cracking even under temperature fluctuations and minor ground movement.

4. Reduced maintenance burden

The flexible surface was expected to resist cracking and surface deformation, extending whole-life usability.

6.5 Carbon Impact

- 6.2 tCO₂e saving
- 25% reduction vs BAU

Savings are achieved through:

- Use of recycled rubber
- Reduced virgin aggregate demand
- Reduced reliance on traditional drainage infrastructure (e.g. steel & concrete)

CASE STUDY DRAINAGE & PERMEABILITY

Reducing Embodied Carbon Through Sustainable Drainage & Permeable Systems

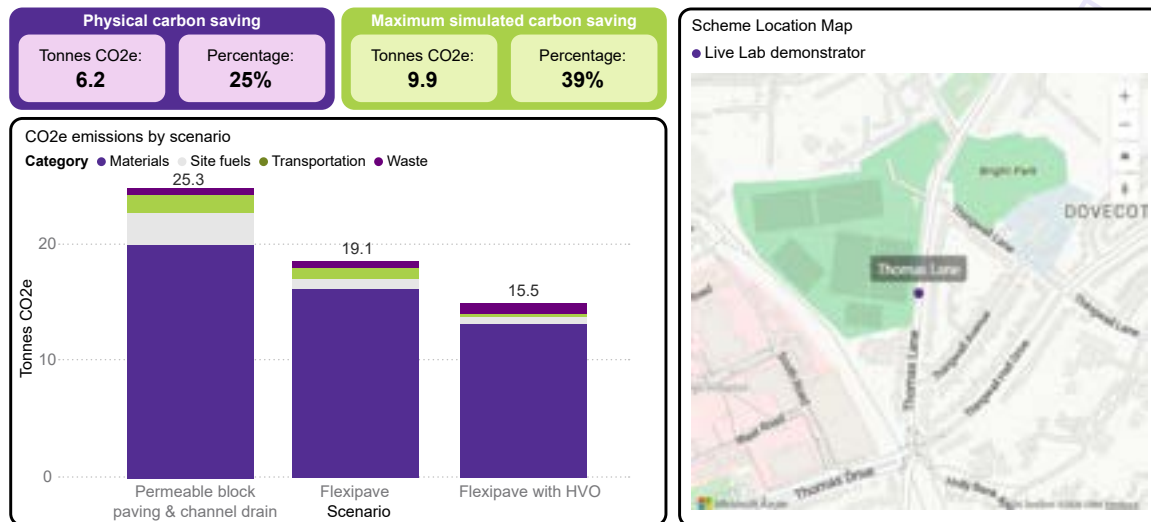


Figure 11: Carbon profiles for Flexipave scheme on Thomas Lane

6.6 Wider Benefits

Stormwater Management Benefits

- Flexipave allows large volumes of water to pass directly through the surfacing, reducing surface runoff and improving stormwater infiltration.
- Reduced need for drainage assets (e.g., gullies, chambers, pipes).
- Helps mitigate localised footway flooding, improving pedestrian accessibility.

Environmental & Circular Economy Benefits

- Diverts end-of-life vehicle tyres from waste streams by converting rubber into high-value surfacing.
- Supports local and regional recycled content targets.
- Lower excavation and build-up requirements reduce material use and associated emissions.

Operational & User Benefits

- Comfortable, slightly flexible walking surface.
- Withstands extreme temperature changes without cracking.
- Can be installed over multiple surface types, enabling retrofitting without full reconstruction.

6.7 Monitoring

Monitoring activities included:

- Visual inspections for cracking, deformation, and edge deterioration.
- Assessment of infiltration performance during and after rainfall events.
- Observations of surface integrity under pedestrian traffic.
- Comparison to adjacent BAU asphalt sections.

Results from early monitoring at Live Labs and evidence from nationwide deployments show:

- No cracking due to the material's dynamic flexibility.
- Consistent permeability, maintaining infiltration over time.
- Stable material behaviour across wet/dry cycles and temperature variations.



CASE STUDY DRAINAGE & PERMEABILITY

Reducing Embodied Carbon Through Sustainable Drainage & Permeable Systems

6.8 Learning and Outcomes

1. Recycled material substitution provides meaningful carbon savings

Flexipave delivered 6.2 tCO₂e (24%) savings versus BAU surfacing at Thomas Lane, largely due to recycled rubber content and reduced reliance on high-carbon materials such as steel and concrete.

2. Highly suitable for footways and lightly-loaded surfaces

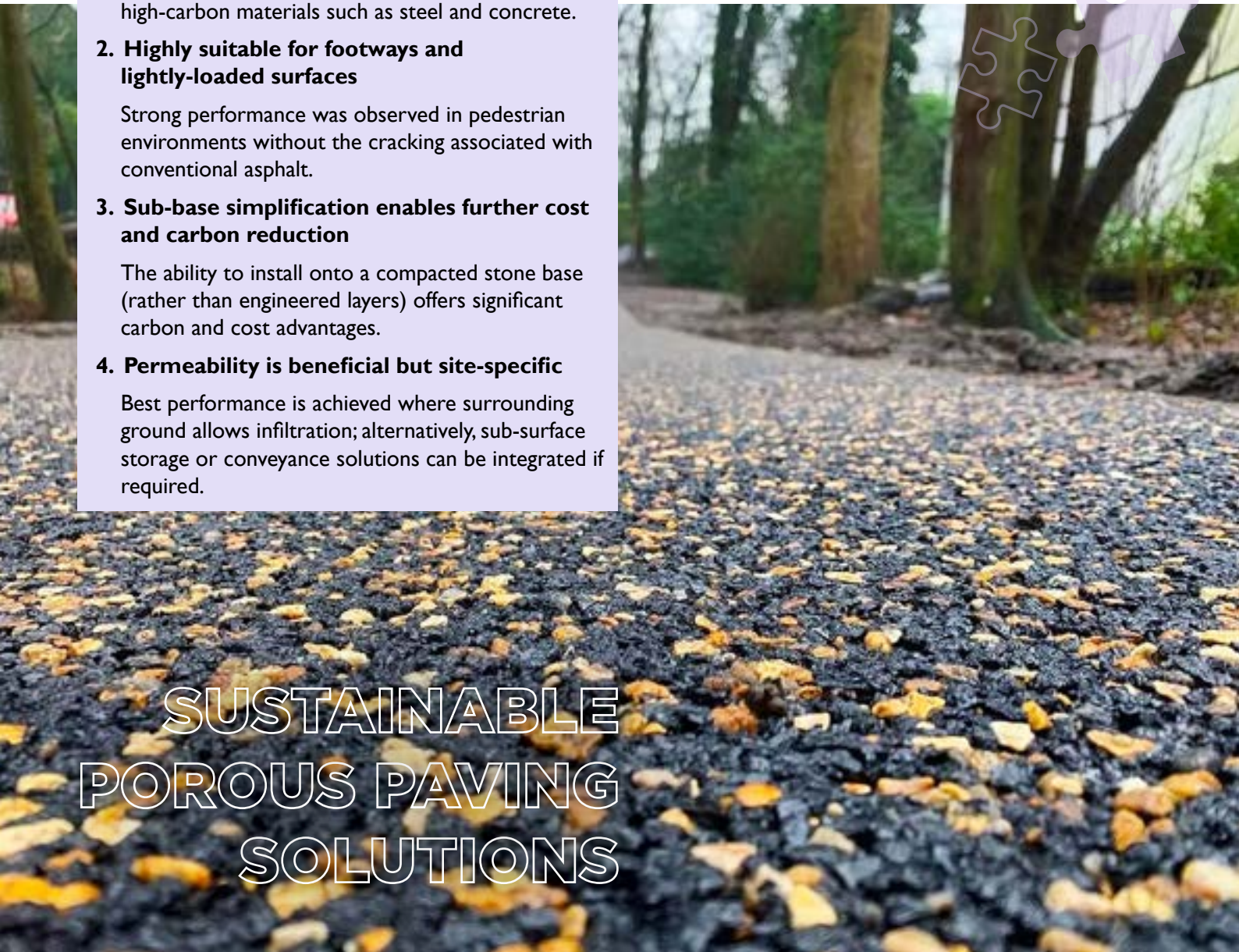
Strong performance was observed in pedestrian environments without the cracking associated with conventional asphalt.

3. Sub-base simplification enables further cost and carbon reduction

The ability to install onto a compacted stone base (rather than engineered layers) offers significant carbon and cost advantages.

4. Permeability is beneficial but site-specific

Best performance is achieved where surrounding ground allows infiltration; alternatively, sub-surface storage or conveyance solutions can be integrated if required.



SUSTAINABLE
POROUS PAVING
SOLUTIONS

CASE STUDY DRAINAGE & PERMEABILITY

Reducing Embodied Carbon Through Sustainable Drainage & Permeable Systems

7. ROSEHILL DRAINAGE SYSTEM

Type: Modular permeable drainage system

Primary Driver: Low-carbon, rapid-install drainage solution using recycled materials

Carbon Mechanism: Material substitution + infrastructure avoidance

Live Labs Deployment: Flood-prone path upgrade in Newsham Park, Liverpool and Castleton Close.

Installed on sites by: Dowhigh Ltd

7.1 Innovation Description

The Rosehill Drainage System is a modular, recycled-rubber drainage solution designed to rapidly remove and disperse surface water from footways, cycle routes, and green corridors. The system consists of two complementary components:

- Rosehill Drainage Mats – high-void recycled rubber mats that absorb and transmit surface water away from saturated ground at Newsham Park.
- RDS Grip Drain – a shallow, linear channel installed at surface level to capture and redirect flows toward an existing outfall at Castleton Close.

Both products are engineered for fast installation, minimal ground disturbance, and reliable all-weather performance. Their flexible structure and recycled-rubber composition make them suitable for sensitive environments, heritage areas, and locations with strict excavation limitations.

The system was installed beneath a gravel surface finish, enabling water to infiltrate vertically before being carried laterally away from the site.

7.2 BAU Comparator

The BAU approach for this location would typically involve:

- Deep trench excavation.
- Installation of perforated pipes, chambers, or traditional drains.
- Use of virgin aggregate.
- Installation of impermeable surfacing elements.

These approaches were not permissible at this site due to Conservation Area restrictions and excavation limits. They also would have increased carbon emissions, construction time, and environmental disturbance.

The Rosehill system provided a light-touch, low-carbon alternative suitable for the constraints.



Figure 12: RDS installation at Newsham Park



CASE STUDY DRAINAGE & PERMEABILITY

Reducing Embodied Carbon Through Sustainable Drainage & Permeable Systems

7.3 Site Selection

The Newsham Park route was chosen due to:

- Chronic surface flooding that rendered the path unusable in wet weather.
- High pedestrian and cycling demand from residents, commuters, schoolchildren, and hospital staff.
- Conservation Area designation, requiring minimal impact to tree roots and historical character.
- Limited depth available for excavation.
- A desire to maintain access to an important off-road active-travel corridor.
- Live weather conditions creating an opportunity to test system performance in real-time storm events (including heavy rain from Storm Chandra).

These constraints created an ideal environment to evaluate a modular drainage system that requires minimal excavation and can be installed during adverse weather.

Figure 13: Installation at Castleton Close



Castleton Close was selected for the Rosehill drainage trial because it forms part of a key section of the TransPennine active-travel route, where frequent flooding regularly rendered the path unusable for walkers and cyclists. The location had a long-standing history of surface water accumulation due to low-lying ground conditions and limited existing drainage capacity, making it an ideal testbed for a shallow, low-excavation drainage solution. Its setting within a residential area also meant high community impact when the route became inaccessible, affecting daily journeys, and local mobility. These combined factors made Castleton Close a representative and high-value location for evaluating the effectiveness and scalability of the Rosehill Drainage System across Liverpool's wider active-travel network.



Figure 14: Before installation Newsham Park (top) & Castleton Close (bottom)



CASE STUDY DRAINAGE & PERMEABILITY

Reducing Embodied Carbon Through Sustainable Drainage & Permeable Systems

7.4 Hypothesis

The project team anticipated that the Rosehill system would:

1. Eliminate localised flooding by capturing and redistributing surface water within a shallow build-up.
2. Reduce embodied carbon through the use of recycled rubber components and by avoiding deep trenching or large-scale excavation.
3. Improve route usability for walking and cycling, particularly during winter months.
4. Minimise environmental impact, supporting Conservation Area requirements.
5. Enable rapid installation, even in wet conditions.

7.5 Carbon Impact

- 6.3 tCO₂e saving
- 82% reduction vs BAU

Carbon reductions are achieved through:

- Reduced cement content
- Lower embodied carbon materials
- Modular installation reducing excavation intensity

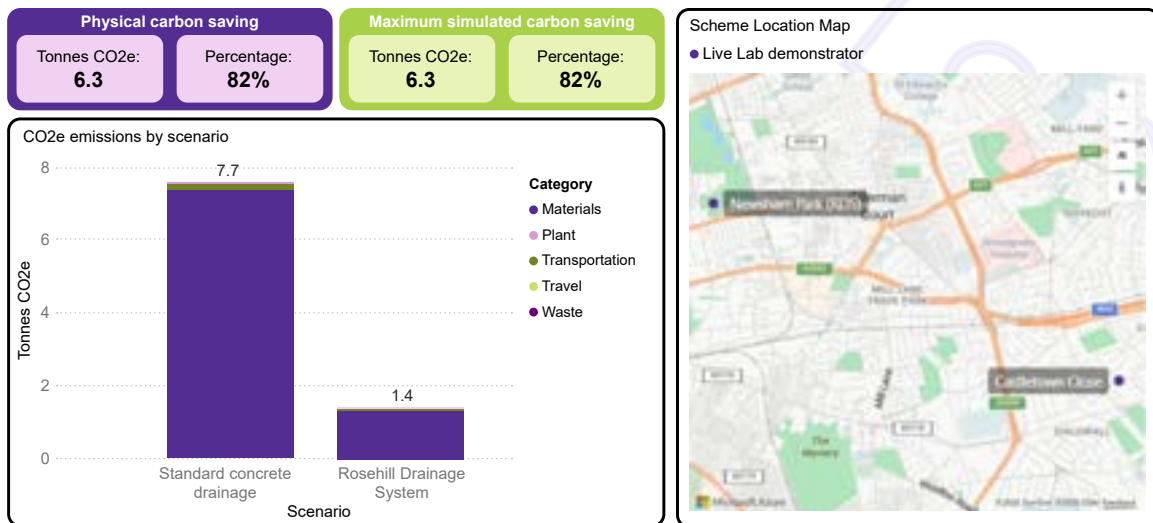


Figure 15: Carbon profiles for Rosehill Drainage System schemes at Castletown Close and Newsham Park

CASE STUDY DRAINAGE & PERMEABILITY

Reducing Embodied Carbon Through Sustainable Drainage & Permeable Systems

7.6 Wider Benefits

Stormwater & Climate Resilience

- Flooding on the route was eliminated through winter 2025, with no pooling observed after installation.
- The modular mats provide passive, maintenance-light drainage without reliance on piped infrastructure.
- The system enhances resilience by functioning effectively during high-intensity storms.

Environmental Benefits

- Made from recycled rubber, supporting circular-economy objectives.
- Minimal excavation protects sensitive tree roots and reduces soil disturbance.
- Lower embodied carbon compared to deep-trench drain systems.

Active Travel & Community Benefits

- Restores a vital off-road walking and cycling connection between the neighbourhoods of Anfield, Fairfield, Tuebrook, and Kensington.
- Provides safer, year-round access for students at St Francis of Assisi Secondary School and workers travelling to/from Edge Lane Innovation Park.
- Avoids a dangerous 2-mile detour along busy roads.
- Early community feedback has been strongly positive.

7.7 Monitoring

Monitoring included:

- Visual inspections after rainfall events.
- Assessment of gravel-surface behaviour above drainage mats.
- Checks on channel outflow and performance during storms.

- User feedback from local residents and community groups.

To date, observations confirm:

- No standing water throughout winter 2025.
- Stable performance during persistent wet conditions.
- No surface erosion or displacement of the gravel layer.
- Improved accessibility and reinstated year-round usage.

Long-term performance will continue to be monitored across the Live Labs 2 programme.

7.8 Learning and Outcomes

1. Modular drainage can outperform conventional systems in constrained sites

Where excavation is limited, mats and shallow drains offer a viable alternative to piped infrastructure.

2. Recycled-rubber systems support carbon and circular-economy goals

Significant carbon savings arise from material substitution and reduced excavation.

3. Installation is highly tolerant of wet weather

The system was successfully installed during prolonged rainfall, demonstrating practical resilience.

4. Supports active travel objectives

Reliable drainage improves safety and encourages walking and cycling year-round.

5. Fully scalable across Liverpool's network

The lightweight, fast-install nature of the system makes it ideal for other footways, park routes, and verge paths experiencing surface flooding.



Figure 16: RDS at Castleton Close

CASE STUDY DRAINAGE & PERMEABILITY

Reducing Embodied Carbon Through Sustainable Drainage & Permeable Systems

8. Trial Findings

The Drainage & Permeability category demonstrates that measurable carbon reduction can be achieved through three distinct mechanisms evaluated across the three Live Labs innovations:

1. Infrastructure Avoidance (Kiacrete)

Kiacrete's high-permeability concrete reduces or eliminates the need for conventional piped drainage, chambers, gullies and deep excavation.

2. Recycled Material Substitution (Flexipave)

Flexipave achieves significant carbon savings by replacing virgin aggregates with recycled tyre rubber, combined with a flexible binder that enables installation onto simple stone sub-bases. This reduces material volumes, transport emissions and waste - all contributing to lower embodied carbon.

3. Concrete Reduction & Modular Systems (Rosehill Drainage)

The Rosehill Drainage System uses recycled rubber modular components to move water laterally through shallow installations. By avoiding deep trenching and substituting concrete and pipe infrastructure, the system delivers both carbon savings and enhanced constructability in sensitive environments.

Cross-Category Insights

- Traditional drainage solutions are materially intensive and carbon-heavy. Deep excavations, concrete chambers and piped networks significantly increase embodied carbon compared with low-depth permeable systems.
- Sustainable drainage systems (SuDS) offer dual benefits: reduced carbon and improved resilience to surface water flooding - critical under intensifying storm patterns.
- Whole-life modelling is essential. Many carbon benefits only become visible over 20-40 year asset lifespans, especially for technologies that extend service life or remove repeat maintenance.
- Permeable systems enhance safety and accessibility,

reducing puddling, slip risk and route closures across footways, cycleways and public spaces.

- Modular drainage enables rapid installation, particularly valuable during constrained working windows, adverse weather or environmentally sensitive projects.

9. Recommendations for Business-As-Usual Integration

To integrate low-carbon drainage solutions into standard highways and public realm practice, the following actions are recommended:

Design & Engineering

- Incorporate whole-life carbon modelling into early design stages for all highway drainage schemes.
- Prioritise permeable systems where ground conditions permit infiltration, or where shallow outfalls and attenuation can be integrated.
- Reduce cement-based infrastructure by adopting modular, recycled-content alternatives for low-depth drainage corridors.

Standards & Procurement

- Embed SuDS-first principles into highway specification documents, asset standards and tender requirements.
- Recognise infrastructure avoidance as a legitimate and preferred carbon reduction strategy in appraisal processes.
- Specify recycled-content materials, particularly where performance evidence from Live Labs is now available.

10. Testimonial

For the first time in years, the path stays dry through winter. It's made a huge difference for getting to school and for walking and cycling around the park without having to take the long detour.

*Local Resident
& Route user*