NZ TRANSPORT AGENCY
WAKA KOTAHI

Carbon Reduction Opportunities For Road Infrastructure

Visual Guide

May 2025

Version 1.0

Contents

Overview

New Zealand Transport Agency Waka Kotahi (NZTA) has a critical role in planning, developing, and operating the land transport system to keep everyone moving. Our transition will require us to change the way we do things over the next 30 years. Our climate change action focuses on reducing greenhouse gas emissions, adapting to a changing climate and reducing harm to the environment from land transport activities.

This guide contributes to NZTA's commitments to deliver land transport infrastructure in a resource-efficient manner which helps minimise environmental impacts, and wider efforts to **integrate resource efficiency into project delivery decision making processes to drive resource efficient, cost effective and low carbon design**.

This guide also helps to support the implementation and integration of **NZTA's policies and strategies** relating to resource efficiency and decarbonisation of the New Zealand road network, and the **New Zealand Government's emissions reduction and land transport legislation and policies**.

Key legislation and policies that this guide helps to support:

Climate Change Response (Zero Carbon) Amendment Act 2019 has set a greenhouse gas emissions reduction target for New Zealand to reduce net emissions of all greenhouse gases (except biogenic methane) to zero by 2050.

Carbon Neutral Government Programme (CNGP) The programme's aim is to make a number of organisations within the public sector carbon neutral from 2025, and measure and publicly report on their emissions.

NZ Government Policy Statement on land transport 2024 has a strategic priority focus on improving value for money from transport investment.

New Zealand's second Emissions Reduction Plan (ERP2) sets out priorities for cost effectively reducing emissions to meet national and international targets, and supporting the transition to a low emissions economy, including support for green building and construction practices, electrification of heavy vehicles and waste reduction.

NZTA's resource efficiency policy and strategy that this guide helps to support:

Te Hiringa o te Taiao - NZTA's Resource Efficiency Strategy has a long-term objective for projects to have net zero emissions by 2050, and interim objectives to establish emissions baseline and reduction targets and integrate resource and energy efficiency and waste minimisation into project delivery processes and significantly increase recycled and alternative materials.

NZTA's Resource Efficiency Policy for Infrastructure Delivery & Maintenance outlines resource efficiency evaluation, planning and reduction requirements for all new infrastructure delivery projects and maintenance contracts.

Disclaimer

- This visual guide is intended to support the optimisation of low carbon and cost neutral/saving initiatives in roading infrastructure projects, in alignment with NZTA policies and standards.
- The information provided in this document is general guidance only.
- Personnel responsible for the delivery of projects shall undertake their own due diligence as to the applicability of materials and products listed against relevant asset owner standards and specifications.
- The information provided in this guide is based on currently available at the time of publication industry reports and information obtained from subject matter experts at NZTA and Beca. It is intended that this guide will be periodically updated to incorporate new industry data and information as this becomes available.

Purpose

This guide supports designers involved in capital and maintenance roading projects in New Zealand to integrate resource efficiency and carbon reduction into the project lifecycle. This guide contains potential carbon and cost reduction opportunities currently available in New Zealand in a simple, visual format for designers to navigate.

Methodology

A variety of information sources were used to develop the guide, including research and studies commissioned by NZTA, information from recent NZTA projects, and industry research and best practice guidelines, together with inputs from industry specialists working on roading projects in New Zealand. Publicly available information sources are included at the end of this guide.

Scope

The selected initiatives focus on reduction in **embodied (materials and fuel) carbon** during construction and maintenance of roading assets. A number of initiatives relating to other emissions sources such as operational energy and enabled emissions (vehicle related emissions during asset use) have also been included.

Initiatives in this guide relate to **carbon emissions intensive materials and fuel** that together are responsible for most of the embodied emissions during the construction and maintenance of roading projects.

Asset related initiatives are mainly related to **pavements and bridges**. Initiatives related to other roading asset types such as drainage works, minor structures, and barriers, have been included where possible.

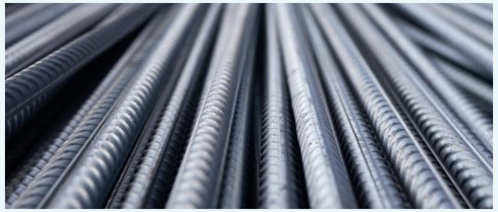
Pavements

Bridges

Other Roading Assets

Asphalt

Aggregate



Steel

Concrete

Fuel

This guide presents a snapshot in time of current New Zealand good practice opportunities and potential innovations for carbon reduction that have been highlighted in the information sources and by industry specialists.

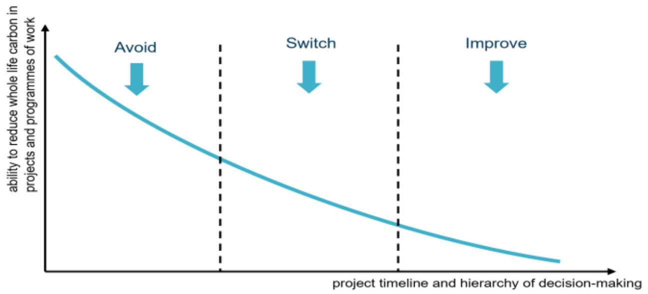
The decarbonisation landscape for construction projects and materials in New Zealand and overseas is constantly changing and difficult to predict. There are likely to be design initiatives that have not been included are being investigated in the New Zealand or overseas context and may become implementable and best practice over time. Likewise, some of the less common and innovative initiatives in this guide will not have been fully investigated or implemented on projects yet and some may prove to be not be feasible in the short to medium or longer term.

Design Approach

Many resources, reports, guidelines and tools have been published internationally and in New Zealand that provide high-level guidance on approaches to design that can enable carbon reduction. The intent of this guide is not to replicate those resources, but rather to provide a quick reference for specific practical initiatives that can be used in conjunction with design approaches.

The most impactful steps that designers can take are to follow good practice carbon management processes and ensure carbon is considered at the earliest opportunity and throughout the project lifecycle.

Good industry practice is the use of standard **PAS 2080: 2023 Carbon management in buildings and infrastructure**. PAS 2080 is a practical 'how to' guide for decarbonising infrastructure, over the whole lifecycle. The standard highlights the need for early-stage targeting of decarbonisation activities to achieve the best outcomes (see diagram below) and stresses the importance of leadership, communication, and collaboration. It also outlines key considerations for project delivery and procurement such as focusing on the carbon hierarchy of 'avoid-shift-reduce' whole of life approach, integration of carbon into decision making and target setting.



The carbon reduction hierarchy focuses on the need to identify whole life carbon reduction early in the project delivery cycle, where the opportunity to reduce carbon emissions is greatest.

Recommended further reading and resources are listed below:

NZTA Resource Efficiency Specification ***NZTA Guideline for Infrastructure Delivery and Maintenance***	These documents should be used on all projects and outline requirements and supporting guidance for developing a resource efficiency and waste minimisation plan, evaluating opportunities, target setting and reporting and provide practical guidance for infrastructure improvement projects at all project life cycle phases (business case to design and construction), as well as maintenance contracts.
Project Emissions Estimation Tool (PEET) **NZTA, Auckland Transport and KiwiRail**	Tool to support carbon emissions estimation in the early stages of a land transport infrastructure project. Carbon reduction analysis component of the tool indicates opportunities to reduce carbon and estimated emissions compared to business-as-usual base case.
ISC Sustainability rating scheme **Infrastructure Sustainability Council**	Required for projects over $500M. Carbon credit requirements, if selected, will support carbon reduction through project lifecycle.
RICS Whole life carbon assessment standard **Royal Institution of Chartered Surveyors (2023)**	Global best practice standard for consistent carbon measurement in the built environment.
SESOC Top Tips for Low Carbon Design **Structural Engineering Society of New Zealand (2024)**	Carbon reduction design process tips and advice for designers, related to buildings but covering key high emissions materials applicable to infrastructure and roading assets.
Austroads website and guidelines	Useful for general guidance. *Carbon Reduction and the Use of Low Carbon Concrete* and *Engineered Laminated Timber Bridge Construction* reports were in progress/pending publication at date of publication of this guide.

As well as resource and materials use from an emissions perspective, designers should also consider potential whole of life impacts (including during maintenance and at end-of-life) on the environment during design development, optioneering and materials selection. **NZTA's *Framework and guidance for the assessment of environmental harm from alternative materials and products proposed for use on the road corridor*** suggests key factors to consider when evaluating potential environmental issues.

Navigating the Guide

The guide features ten cards, each outlining potential decarbonisation initiatives for roading infrastructure. For ease of navigation these are organised into **four asset** and **six material** cards.

Designers can navigate directly to the specific cards relating to their technical discipline. Some initiatives overlap asset types and/or materials and fuels.

A designer may typically have less ability to influence some initiatives included in this guide, notably several initiatives on the fuel and energy use card. These have been included to give designers additional information that may inform discussions to support these types of initiatives during the design phase, for example through early contractor or supplier engagement, contracts and specifications requirements or tender selection processes.

Assets

Pavements

Bridges (2 cards)

Other Assets

Materials and Fuel

Asphalt and Bitumen (2 cards)

Aggregate

Steel

Concrete

Fuel and energy use

Navigating the Asset and Material Cards

Initiatives Overview: Listed along the left-hand side, initiatives specific to an asset or material

Quick win initiatives:
Identified based on cost and carbon savings and ease of implementation

Assessment criteria: Categorised to provide the designer with overview of potential considerations or constraints.

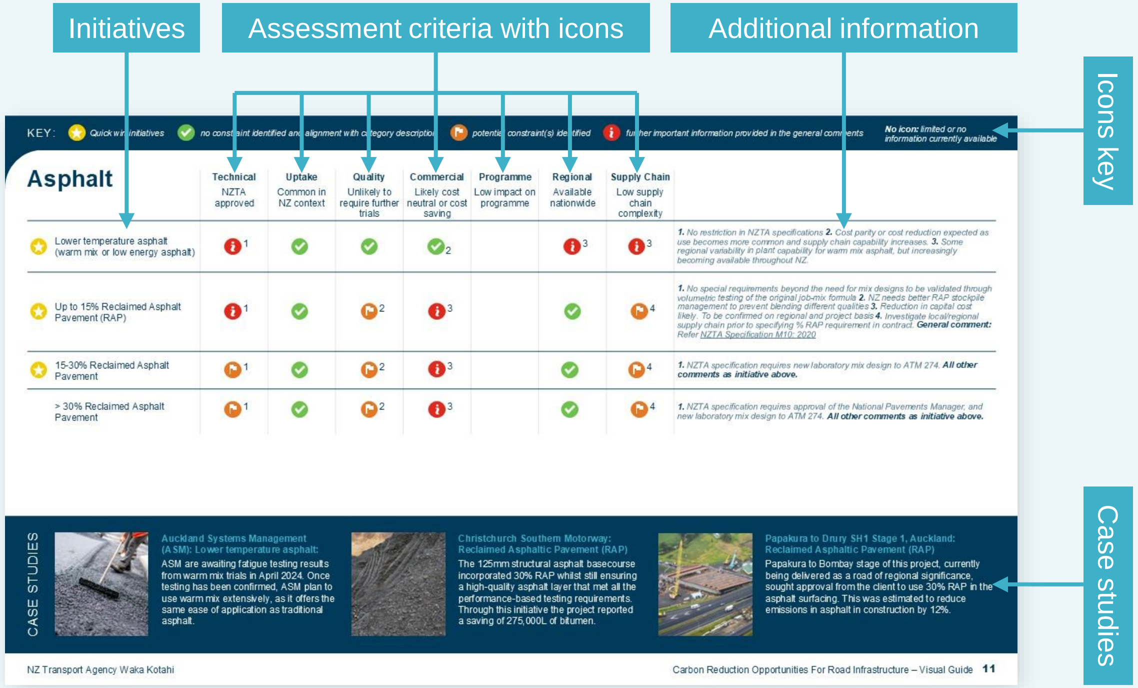
- **Technical:** NZTA approved or (conversely) whether additional specification requirements may be necessary i.e., tests or approval by an engineer
- **Uptake:** Common in NZ context or relatively novel or innovative
- **Quality:** Quality known or likely to require further trials
- **Commercial:** Likely cost neutral/cost saving or potential cost sensitivity compared to alternatives proposed (early investigation of capital and whole-of-life costs recommended)
- **Programme:** Low impact on programme or possible design or construction phase programme implications
- **Regional:** Available nationwide or potential regional variability in availability or applicability
- **Supply Chain:** Low complexity supply chain or early engagement with suppliers recommended

Icons:

	no constraint identified and alignment with category description
	potential constraint(s) identified
	further important information provided in the general comments
No icon	limited or no information currently available

Additional information: Further notes and commentary associated with icon numbers, and further information and references.

Case Studies: Each asset and material card is complemented by case studies showcasing New Zealand examples of innovative initiatives. Case studies range from completed projects to projects currently underway and possible future initiatives, providing an indication of industry direction.



Navigate to the appropriate card relevant to your technical discipline and area of interest:

- Initiative tables specific to **asset types:** Pavements, Bridges, and Other Roading Assets.
- Initiative tables specific to **construction materials** and **fuel:** Asphalt, Bitumen, Concrete, Steel, Aggregate, and Fuel and Energy use.

KEY: ★ Quick win initiatives ✔ no constraint identified and alignment with category description ⚑ potential constraint(s) identified ⓘ further important information provided in the general comments **No icon:** limited or no information currently available

Pavements

	Technical NZTA approved	Uptake Common in NZ context	Quality Unlikely to require further trials	Commercial Likely cost neutral or cost saving	Programme Low impact on programme	Regional Available nationwide	Supply Chain Low supply chain complexity	
★ Alignment optimisation to reduce imported fill	✔	✔	✔	✔	✔	✔	✔	***General comment:*** *Examples include - reduced crest values, median width reduction, curve widening. Note- this initiative should be considered for all pavements projects.*
★ Asphalt performance testing to reduce pavement thickness	✔	✔	⚑ 1	✔	⚑ 2			***1.*** *Testing to Austroads ATM274.* ***General comment:*** *Refer NZTA Specification M10: 2020 (ATM 274 replaces AGPT T274). May not be appropriate for low noise pavements (LN3 and LN5) as thickness is key to performance.*
Long life pavement options		✔		⚑ 1	✔			***1.*** *May be capital cost implication, may reduce whole of life cost.* ***General comment:*** *Long life pavement examples include deep lift, epoxy surfacing, EME2. Note, each option considered will require further investigation to understand whole of life cost and carbon saving benefits. No technical barrier to use of EME2, refer NZTA M32 specification.*
Low rolling resistance (stiffer and lower texture) pavements		✔		⚑ 1		⚑ 2		***1.*** *May be higher capital cost, potential for whole of life cost saving.* ***2.*** *Not done in all locations - consider for high volume network.* ***General comment:*** *Emissions savings related to vehicle use during asset lifetime, not upfront embodied (materials and fuel).*
NZ pozzolans as alternative to cement in modified/bound pavement layers	✔	⚑ 1	⚑ 2	⚑ 3	⚑ 4	⚑ 5		***1.*** *Increasing use for non-structural and lower grade cement applications in NZ* ***2.*** *May reduce early strength development. Variability in material properties from different sources.* ***3.*** *Possible premium, likely to reduce as becomes more widely used.* ***4.*** *May reduce early strength development.* ***5.*** *Potential variability in product sourcing/availability.*
★ In situ pavement stabilisation	✔	✔	⚑ 1	✔	✔	✔		***1.*** *Limited effectiveness on pavements with poor quality materials or structural defects.* ***General comment:*** *Considered business as usual in NZ context, should be used if no technical reason not to.*

CASE STUDIES

Takitumu North Link, Tauranga: SAC pavement replaced HiLab

Stage 1 of this project comprises a new 6.8km alignment. High strength Low-Fines Aggregate Base pavement (Hi-Lab) was replaced with Structural Asphalt Pavement (SAC). This reduced both material use in construction and maintenance and is expected to reduce overall material requirements by 5%. It should be noted that upfront and whole of life costs associated with this initiative require further investigation.

EME2

EME2 is a high-modulus asphalt designed for heavy-duty pavements exposed to high traffic volumes and complex stress conditions—such as roundabouts, intersections, motorways, airports, and ports. Originally developed in France over 30 years ago, Road Science has been manufacturing EME2 for several years as the only local solution. EME2 can reduce structural asphalt thickness by up to 30% while significantly extending pavement life. Road Science successfully applied their EME2 mix in intersection repairs in Hamilton and New Plymouth in 2017, helping to combat premature rutting and improve long-term performance.

KEY: ★ *Quick win initiatives* ✓ *no constraint identified and alignment with category description* ⚑ *potential constraint(s) identified* ℹ *further important information provided in the general comments* ***No icon:*** *limited or no information currently available*

Bridges

	Bridges	**Technical** NZTA approved	**Uptake** Common in NZ context	**Quality** Unlikely to require further trials	**Commercial** Likely cost neutral or cost saving	**Programme** Low impact on programme	**Regional** Available nationwide	**Supply Chain** Low supply chain complexity	
★	Basis of design review on project-by-project basis to ensure fit for purpose	⚑ 1	✓						***1.*** *Designer may need to ask for departure from standards* ***General comment:*** *Examples include review of design/service life, overall alignment width requirements, seismic loading, debris loading.*
★	Structural forms that reduce materials use and minimise impacts of seismic/other loadings	✓	✓						***General comment - superstructure:*** *Assess embodied carbon and cost of alternative bridge girder types on case by case/project basis. Depending on span, prestressed concrete, steel, composite or timber bridge superstructure types may be more cost/carbon efficient. For both prestressed concrete and steel girder bridge types embodied carbon emissions from steel outweigh concrete significantly. Don't minimise concrete volumes without considering combined emissions from concrete and steel.* ***General comment - substructure:*** *Consider shallow foundations for single span bridges and design for additional movement to meet seismic requirements (shallow foundations have significantly lower embodied carbon than piled). Include embodied emissions of foundations in options assessments. Refer NZTA Technical Advice Notes #24-01 (SH bridges) and #24-02 (Local bridges), December 2024.*
	Bridge service life increase (i.e., 120-year design life as per Euro code)	⚑ 1			⚑ 2				***1.*** *May require NZTA approval.* ***2.*** *Upfront cost may be higher, likely whole of life cost reduction.* ***General comment:*** *Likely applicable for larger bridge projects only. Requires further investigation to understand whole of life cost and carbon saving benefits.*
	Engineered timber bridge superstructure	ℹ 1	⚑ 2	⚑					***1.*** *Timber superstructure - NZTA preferred option for optioneering pathway for bridges up to 50m span when vertical clearance requirements don't govern design.(See also general comment below)* ***2.*** *Refer Onetai case study, first timber road bridge in NZ.* ***3.*** *Need to demonstrate meets durability requirements.* ***General comment:*** *Refer NZTA Roads of National Significance Standardised Designs Framework, August 2024 and #22-02 NZTA Interim technical standards for the design of timber bridges. Refer also upcoming Austroads Engineered laminated timber bridges research report (expected publication 2025). Note, may require risk sharing approach with client, suppliers as challenge for designers to demonstrate durability for the required 100-year design life.*
	For timber bridges, allowable design life reduction	⚑ 1	⚑	⚑					***1.*** *Will require NZTA approval.* ***General comment:*** *Reducing design life may support uptake of timber bridges on network*

CASE STUDIES

SH26 Onetai stream, Waikato: Timber bridge

Onetai bridge replacement is the first state highway bridge built from timber in 50 years, completed in early 2025. The timber superstructure is being piloted by NZTA as a prototype solution for replacement of short-span vehicle bridges. The engineered glulam timber superstructure and plywood deck has a similar construction cost to concrete.

KEY: ★ Quick win initiatives ✓ no constraint identified and alignment with category description ⚑ potential constraint(s) identified ℹ further important information provided in the general comments **No icon:** limited or no information currently available

Bridges

		Technical NZTA approved	Uptake Common in NZ context	Quality Unlikely to require further trials	Commercial Likely cost neutral or cost saving	Programme Low impact on programme	Regional Available nationwide	Supply Chain Low supply chain complexity	
	Lower grade concrete for pre-cast concrete bridge components					⚑ 1			***1.** May increase production time. **General comment:** Higher grade concrete may be preferred by pre-cast supplier to allow quicker removal from moulds.*
	Permanent steel pile casings as structural element in foundation design	⚑ 1			✓				***1.** No clear approval and compliance path for ductile behaviour. Need to design to AASHTO Standards until New Zealand specific design guidance is released. **General comment:** Will require further investigation to confirm cost and carbon savings.*
	Composite bridges								***General comment:** Examples include fibre reinforced polymer structures, steel/concrete/timber composite structures and/or bio composite structures Initiative requires further investigation to understand cost and carbon savings.*
★	Existing bridges/structures assessment to extend life or reuse elsewhere	✓	✓		✓				***General comment:** Challenges to re-use of existing structures include sign-off by designer or supplier.*
★	Steel plate strengthening to extend life of existing bridges	✓	✓		✓			✓	
	Fibre reinforced polymer strengthening to extend life of existing bridges		✓		✓			✓	***General comment:** Consider potential environmental risks associated with plastics/fossil-fuel based petrochemical materials. Consider whole of life, including maintenance and end-of-life. Check if appropriate with NZTA on a case-by-case basis. Also refer NZTA Framework and guidance for the assessment of environmental harm from alternative materials and products proposed for use on the road corridor.*
	Timber as bridge deck replacement alternative material	✓	⚑ 1	⚑ 2					***1.** Not common but increasingly used in NZ context **2.** Need to demonstrate meets durability requirements. **General comment:** Use of timber may be beneficial for existing foundations (lighter construction material).*
	Digital approach to optimise design	✓	✓		✓				***General comment:** Examples include digital twin/design software, hydrology modelling software. Refer also NZTA Digital technologies for decarbonisation guidance.*

CASE STUDIES

Grafton Bridge, Auckland: Digital twin

Beca worked alongside Auckland Transport (AT) to create a digital twin to help monitor and maintain this century old bridge. This model helps AT to understand the carbon and cost impact of different design options.

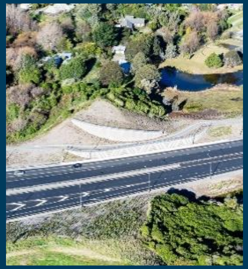
Takitumu North Link, Tauranga: Digital twin

The Takitimu North link (TNL) project has used 3D visualisation tool known as iTwin, allowing different disciplines involved in building a road to share design information in one place. This digital twin approach has significantly optimized earthworks and minimized environmental impact. The use of iTwin facilitated the reuse of earth cuts as fill onsite, eliminating the need for imported fill or offsite material disposal. This optimization prevented 22,000 truck movements and 900,000 kilometers of journeys on local roads, resulting in a 560-tonne reduction in carbon emissions. The model-based approach also allowed for rapid real-time updates, making the design process more efficient.

Other Assets

	Technical NZTA approved	**Uptake** Common in NZ context	**Quality** Unlikely to require further trials	**Commercial** Likely cost neutral or cost saving	**Programme** Low impact on programme	**Regional** Available nationwide	**Supply Chain** Low supply chain complexity	
★ Timber as alternative to steel/concrete	✓	ⓘ 1	✓	✓				***1.*** *For some applications, i.e., pedestrian boardwalks and shared user paths, timber likely to be the default option in NZ context. For other applications use of timber may be less common.* ***General comment:*** *Examples include pedestrian/shared user bridges/boardwalks, soldier piles as debris arrestors, furniture, posts, kerbs, retaining and noise walls.*
★ Driven steel post railings for steel road barriers (alternative to insitu concrete footings)	✓	✓	⚑ 1	✓	✓	✓	✓	***1.*** *May depend on ground conditions*
Nature-based solutions	✓	✓	✓	ⓘ 1				***1.*** *Efficacy as a carbon (and cost) reduction measure will require further investigation on a case-by-case basis.* ***General comment:*** *In this context nature-based solutions would include non-engineered solutions for management of stormwater, floodwater or erosion management. Examples may include wetlands and swales or planted embankments, or reduction in below ground engineered solutions such as piping or conventional water quality devices. Realisation of nature-based solution requires early planning and may often require larger designation footprint or real estate. Cost benefits are often realised. Carbon benefits may be realised but there are often other benefits to adopting nature-based solutions, such as protection, restoration or regeneration of the environment and ecosystems or flood resilience.*
Plastic alternatives for larger diameter concrete pipes and drainage components	✓	✓	✓				✓	***General comment:*** *Further investigation required to confirm carbon/cost savings. Consider potential environmental risks associated with plastics/fossil-fuel based petrochemical materials. Consider whole of life, including maintenance and end-of-life. Check if appropriate with NZTA on a case-by-case. Also refer* *NZTA Framework and guidance for the assessment of environmental harm from alternative materials and products proposed for use on the road corridor.*
Solar lighting and signage								***General comment:*** *Emissions savings related to operational energy of asset during asset lifetime, not upfront embodied (materials and fuel).*

CASE STUDIES



Mackays to Pekapeka, Wellington: Nature based solutions

This 18 km expressway was complemented by ecological enhancements including 140 hectares of new native planting, 10.5 hectares of restored or newly created wetlands and 6 km of stream riparian planting. The wetlands, streams, and ecological mitigation measures were intricately integrated with stormwater management systems, focusing on both attenuation and treatment. A notable feature was a 10m wide, 1m deep swale along the expressway. An alternative piping system was considered, but would have necessitated altering the road's elevation. Consent compliance requirements and associated cost savings were key drivers for this feature and the other ecological enhancements.

Carrington Road, Auckland (Auckland Transport): Nature based solutions

The original design for widening this existing road featured a large underground stormwater tank. However, an opportunity emerged to incorporate stream daylighting of an existing grass berm along a side street. Daylighting involves uncovering and restoring a previously buried watercourse, allowing water that would otherwise be piped underground to flow above ground in a more natural, river-like channel and ultimately discharge into a local creek. This approach leverages the green space for a water-sensitive design, providing lower capital, carbon, and maintenance costs than conventional water quality devices typically used in road corridors.

Image: Auckland Transport

KEY: ★ Quick win initiatives ✓ no constraint identified and alignment with category description ⚑ potential constraint(s) identified ⓘ further important information provided in the general comments **No icon:** limited or no information currently available

Asphalt

	Technical NZTA approved	Uptake Common in NZ context	Quality Unlikely to require further trials	Commercial Likely cost neutral or cost saving	Programme Low impact on programme	Regional Available nationwide	Supply Chain Low supply chain complexity	
★ Lower temperature asphalt (warm mix or low energy asphalt)	✓	✓	✓	✓ 1		ⓘ 2	ⓘ 2	***1.*** *Cost parity or cost reduction expected as use becomes more common and supply chain capability increases.* ***2.*** *Some regional variability in plant capability for warm mix asphalt, but increasingly becoming available throughout NZ.*
★ Up to 15% Reclaimed Asphalt Pavement (RAP)	ⓘ 1	✓	⚑ 2	ⓘ 3		✓	⚑ 4	***1.*** *No special requirements beyond the need for mix designs to be validated through volumetric testing of the original job-mix formula* ***2.*** *NZ needs better RAP stockpile management to prevent blending different qualities* ***3.*** *Reduction in capital cost likely. To be confirmed on regional and project basis* ***4.*** *Investigate local/regional supply chain prior to specifying % RAP requirement in contract.* ***General comment:*** *Refer NZTA Specification M10: 2020*
★ 15-30% Reclaimed Asphalt Pavement	⚑ 1	✓	⚑ 2	ⓘ 3		✓	⚑ 4	***1.*** *NZTA specification requires new laboratory mix design to ATM 274.* ***All other comments as initiative above.***
> 30% Reclaimed Asphalt Pavement	⚑ 1	✓	⚑ 2	ⓘ 3		✓	⚑ 4	***1.*** *NZTA specification requires approval of the National Pavements Manager, and new laboratory mix design to ATM 274.* ***All other comments as initiative above.***

CASE STUDIES

Auckland Systems Management (ASM): Lower temperature asphalt:

In 2025 a portion ASM's AC14 programme was laid using Reduced Energy Asphalt (REA), with successful results. Trials for AC20 REA are planned in 2025 with expectations of similar results. A key challenge to uptake currently is the variable capability of asphalt plants in Auckland to supply REA.

Christchurch Southern Motorway: Reclaimed Asphaltic Pavement (RAP)

The 125mm structural asphalt basecourse incorporated 30% RAP whilst still ensuring a high-quality asphalt layer that met all the performance-based testing requirements. Through this initiative the project reported a saving of 275,000L of bitumen.

Papakura to Drury SH1 Stage 1, Auckland: Reclaimed Asphaltic Pavement (RAP)

Papakura to Bombay stage of this project, currently being delivered as a road of regional significance, sought approval from the client to use 30% RAP in the asphalt surfacing. This was estimated to reduce emissions in asphalt in construction by 12%.

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Asphalt

	Technical NZTA approved	Uptake Common in NZ context	Quality Unlikely to require further trials	Commercial Likely cost neutral or cost saving	Programme Low impact on programme	Regional Available nationwide	Supply Chain Low supply chain complexity	
Locally available asphalt mix materials	⚑ 1	✓		ⓘ 2		✓		***1.*** *No technical barrier other than meeting NZTA performance requirements.* ***2.*** *Generally cheaper, but review on case-by-case basis.*
Recycled aggregate in asphalt (slag, glass, other)	✓	✓	⚑ 1	⚑ 2	⚑ 3		⚑ 4	***1.*** *Material variation means supplier standard mix designs cannot be used; additional testing likely required* ***2.*** *Whilst some recycled aggregates could be cost effective, certain recycled aggregates may be higher cost, i.e., ggbs* ***3.*** *Potential programme implication due to testing requirement* ***4.*** *Recycled ggbs chipseal is in demand, therefore supply chain issues likely (also see cost).*
Recycled materials in asphalt (plastics, rubber)		⚑ 1	⚑ 2	⚑		⚑		***1.*** *Common overseas, but less so in New Zealand.* ***2.*** *Material variation means supplier standard mix designs cannot be used; additional testing likely required.* ***General comment:*** *Examples include crumb rubber, soft or hard plastics, recycled textiles. Limited cost and carbon reduction information available. Consider potential environmental risks associated with plastics/fossil-fuel based petrochemical materials. Consider whole- of-life, including maintenance and end-of-life. Check if appropriate with NZTA on a case-by-case. Also refer NZTA Framework and guidance for the assessment of environmental harm from alternative materials and products proposed for use on the road corridor.*

Bitumen

	Technical	Uptake	Quality	Commercial	Programme	Regional	Supply Chain	
Bio bitumen (full or partial replacement of fossil fuel derived bitumen)	⚑ 1	⚑	⚑ 2	⚑ 3	✓		⚑ 4	***1.*** *Current barrier to use in NZTA projects. Refer NZTA M01 Specification and NZTA M01-A Specification.* ***2.*** *Trials are being carried out in NZ.* ***3.*** *May be cost premium, assumed cost reduction as supply increases in NZ.* ***4.*** *Currently supply is limited in NZ (Lignin must be imported, Tall oil pitch is produced in smaller quantities), however commercial upscaling is expected.* ***General comment:*** *Examples include Lignin, a pulp and paper-by-product, and tall oil, obtained from the process of pulping of wood.*
★ Bitumen emulsion (chipseal pavements)	✓	✓	✓	✓	✓	✓	✓	***General comment:*** *Mandated by NZTA since 2024, see case study.*

CASE STUDIES

SH38 Road, Bay of Plenty: Bio-bitumen - Tall Oil Pitch

SH38 is a 150km roading corridor between Wairoa and Murupara. Around 70km of this is unsealed and within the mountainous Te Urewera, homeland of Ngāi Tūhoe. Since 2016 Ngāi Tūhoe has invested in developing a Tall Oil Pitch (TOP) sealing material as an alternative to petroleum-based bitumen. A 20km extension is underway following initial trials which met the project objectives to reduce dust, improve ride quality and maintain the road's natural appearance while upholding Tūhoe values of protecting Te Urewera as kaitiaki.

Bio Bind, by Road Science: Bio-bitumen

Bio Bind is a lower carbon bitumen replacement derived from over 70% renewable resources, primarily trees. Locally manufactured and distributed by Road Science, Bio Bind uses the same paving process and equipment as traditional bitumen and is available in various asphalt products that meet NZTA standards. New Plymouth District Council successfully trialled Bio Bind as part of the New Plymouth Infrastructure Partnership between NPDC and Downer, which encourages innovation in infrastructure maintenance work methods.

StrengthTex, UsedFULLY: Bitumen replacement

StrengthTex is a recycled textile product made from end-of-life textiles, either cotton, polyester, or polycotton by continuous, solvent-free refining. Pellets are added into the asphalt aggregate mix releasing into the asphalt as bitumen during blending as a direct replacement for virgin imported materials. Following a successful roading trial in 2022 with Wellington City Council, NZTA and MBIE have supported UsedFULLY to develop StrengthTex for commercial use. LCA information is available on request.

NZTA Bitumen Emulsion Mandate (chipseal pavements)

From July 2024 NZTA mandated the use of bitumen emulsion for sealing operations for chipseal pavements for all contracts. Chip seal surfacing using bitumen emulsion offers better environmental outcomes, carbon emissions savings and health and safety benefits compared to cut-back bitumen.

KEY: ★ Quick win initiatives ✓ no constraint identified and alignment with category description ⚑ potential constraint(s) identified ⓘ further important information provided in the general comments **No icon:** limited or no information currently available

Concrete

Concrete	**Technical** NZTA approved	**Uptake** Common in NZ context	**Quality** Unlikely to require further trials	**Commercial** Likely cost neutral or cost saving	**Programme** Low impact on programme	**Regional** Available nationwide	**Supply Chain** Low supply chain complexity	
★ Specification of maximum Global Warming Potential for procurement flexibility	✓	✓		⚑ 1	⚑ 2	⚑	⚑ 3	***1.*** *Cost information varies. Likely minimal or no premium to achieve up to 25% carbon reduction. Beyond this, premium generally increases with higher carbon reduction.* ***2****. SCM supply chain issues may impact construction programme* ***3.*** *Imported fly ash is mostly used in NZ.* ***General comment:*** *Specification of maximum GWP, rather than % SCM is recommended. Designer should engage with local suppliers to understand availability and cost implications, and with NZTA to seek approval for specification. Refer to Structural Engineering Society (SESOC) NZ Top Tips for Low Carbon Design Guide for further guidance on specifying GWP and NZ specific GWP benchmarks for different concrete grades. Also refer Austroads Low Carbon Concrete Research report due for publication 2025. This initiative is established in NZ context for in-situ concrete. Further engagement with pre-cast concrete suppliers is required to establish suitability of max GWP specification for procurement of lower carbon pre-cast concrete components.*
NZ pozzolans as cement alternative	✓ 1	⚑ 2	⚑ 3	⚑ 4	⚑ 5	⚑ 6		***1.*** *No NZTA barrier for non-structural use.* ***2.*** *Increasing use for non-structural and lower grade cement applications in NZ, likely to be feasible for structural concrete applications in med-long term.* ***3.*** *May reduce early strength development of concrete, tests show long-term strength good. Variability in material properties from different sources.* ***4.*** *Possible cost premium, likely to reduce as becomes more widely used.* ***5.*** *May reduce early strength development of concrete. 6. Potential variability in product sourcing/availability* ***General comment:*** *Consider use of NZ pozzolans with geopolymer activator such as Neocrete.*
★ Lower strength concrete specification	✓	✓		✓	✓	✓	✓	***General comment:*** *Over-specifying concrete strength results in increasing embodied carbon. Specify only the strength that is actually required in the design of members. If durability provisions in the code require a higher strength, consider taking advantage of that in design. Refer to Structural Engineering Society (SESOC) NZ Top Tips for Low Carbon Design Guide*
Recycled glass as aggregate						⚑ 1	✓	***1.*** *Potential high transportation costs to regional recycling facilities.* ***General comment:*** *Cost and performance implications are not fully understood, recycling into new glass product may be of higher value than use in construction.*

CASE STUDIES

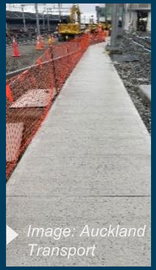
Image: Auckland Transport

Middlemore Footpath, Auckland (Auckland Transport): Fly-ash as Supplementary Cementitious Material (SCM)

The project used a 30% fly ash blend as a SCM in concrete, achieving good strength with no technical issues. However, the project experienced curing delays, impacting the schedule.

Oakley Creek Esplanade Reserve, Auckland (Auckland Transport): GGBS as SCM

An active slip near Great North Road was stabilized using an in-ground concrete lattice structure with low-carbon cement mixes. Laboratory and production trials tested a range of low-carbon concrete mixes with 50 to 70% cement replacement using ground granulated blast-furnace slag (GGBS), achieving a 38% reduction in embodied carbon compared to traditional cement.

Wiri station (Auckland Transport): NZ Pozzolans

A 32m footpath was successfully constructed using a concrete mix with 20% pumice (from Taupo, Central North Island) as a cement replacement. The project will now monitor the footpath's performance to assess potential wider use across the network.


Image: City Rail Link Ltd

City Rail Link, Auckland: Fly-ash as SCM:

The project achieved an average of 29% replacement of cement in concrete with fly-ash from Asia and an estimated 21,280tCO$_2$e emissions reduction. A higher percentage replacement was targeted, however supply chain issues presented difficulties with sourcing of fly-ash. The use of fly-ash replacement was cost neutral compared to OPC and reduced emissions.

City Rail Link, Auckland : Recycled crushed concrete (RCC) as replacement for aggregate in concrete

The project used recycled crushed concrete aggregate (GVRCC10) in a non-structural flowable fill RCC10 concrete supplied by Allied Concrete. This resulted in an estimated carbon emissions saving of 55%. The cost was similar to virgin aggregate.

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Steel

Steel	Technical NZTA approved	Uptake Common in NZ context	Quality Unlikely to require further trials	Commercial Likely cost neutral or cost saving	Programme Low impact on programme	Regional Available nationwide	Supply Chain Low supply chain complexity	
★ Lower carbon steel reinforcement	✓	ⓘ 1	✓	✓	⚑ 2		⚑ 2	***1.*** *Some uptake in NZ* ***2.*** *Longer lead times for overseas suppliers, but not a significant barrier.* ***General comment:*** *Recommend designers engage on project-by-project basis with local suppliers to understand availability and carbon emissions of lower carbon steel, and with NZTA to understand project carbon and cost requirements to inform steel specification. Current industry average GWP is around 4kgCO2e/kg steel. A GWP of around 2kgCO2e is achievable from some overseas suppliers (and will be from NZ produced steel once Glenbrook EAF is complete - see case study below) and as low as 0.5kgCO2e/kg from some overseas sources (see NatSteel case study below).*
★ Lower carbon steel (plate)	✓	ⓘ 1	✓	⚑ 2	⚑ 3	✓	⚑ 3	***1.*** *Some uptake in NZ* ***2.*** *Potential cost premium up to 20% 3. Longer lead times for overseas suppliers, but not a significant barrier.* ***General comment:*** *Recommendations as per lower carbon steel reinforcement. Current industry average GWP for plate steel is around 4kgCO2e. A GWP of around 2.2kgCO2e is achievable from some overseas suppliers and as low as 1kgCO2e/kg from some overseas sources.*
Lower carbon steel (hot rolled)	✓	ⓘ 1	✓	✓	⚑ 2	✓	⚑ 2	***1.*** *Some uptake in NZ* ***2.*** *Longer lead times for overseas suppliers.* ***General comment:*** *Recommendations as per lower carbon steel reinforcement. Current industry average GWP for hot rolled steel is around 3.2kgCO2e. A GWP of around 1kgCO2e is achievable from some overseas suppliers and as low as 0.5kgCO2e/kg from some overseas sources.*
Higher-grade structural steel	✓		✓					***General comment:*** *Requires further investigation to understand availability and cost and carbon saving benefits.*
Higher-grade reinforcement	✓		✓					***General comment:*** *Requires further investigation to understand availability and cost and carbon saving benefits. May only be applicable where ductility requirements for seismic design don't govern (i.e. bridge deck application).*
Glass fibre reinforced polymer (GFRP) reinforcing bar	⚑ 1	⚑ 2						***1.*** *NZTA specifications/design life requirements may restrict use of non-steel reinforcement.* ***2.*** *Not commonly used for structural applications in NZ.* ***General comment:*** *Requires further investigation to understand potential applications and cost and carbon saving benefit. May only be applicable where ductility requirements for seismic design don't govern (i.e. bridge decks application). Consider environmental risks associated with plastics/fossil-fuel based petrochemical materials. Consider whole-of-life, including maintenance and end-of-life. Check if appropriate with NZTA on a case-by-case. Also refer NZTA Framework and guidance for the assessment of environmental harm from alternative materials and products proposed for use on the road corridor.*

CASE STUDIES

New Zealand Steel: Electric Arc Furnace

NZ steel is building a new Electric Arc Furnace (EAF) at its Glenbrook plant which will be operational in early 2026. Once completed, scrap steel, which would have been exported, will now be utilised locally. The EAF will reduce embodied carbon emissions by around half.

Image: NZ Steel

Undisclosed project, Auckland: Lower carbon steel reinforcement

Precast concrete components for this large infrastructure project utilised lower emissions imported reinforcement bars (HR12 and HD20), sourced from NatSteel in Singapore. NatSteel's current EPD indicates a GWP of around 25% of other imported steel reinforcement currently available.

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Aggregate

	Technical NZTA approved	Uptake Common in NZ context	Quality Unlikely to require further trials	Commercial Likely cost neutral or cost saving	Programme Low impact on programme	Regional Available nationwide	Supply Chain Low supply chain complexity	
★ Recycled crushed concrete as basecourse aggregate	ⓘ 1	✔	✔	✔			⚑ 2	***1.*** *No restriction but must be approved by appropriate regional council* ***2.*** *Designers may face challenges in assessing potential availability during design phase.* ***General comment:*** *Refer NZTA guidance on Recycled and alternative materials for transport infrastructure, and NZTA M04 Specification.*
Reclaimed glass as basecourse aggregate	ⓘ 1	✔	✔			⚑ 2	⚑ 3	***1.*** *Reclaimed glass in excess of 5% may be used at the discretion of NZTA* ***2.*** *Potential high transportation costs to regional recycling facilities* ***3.*** *Designers may face challenges in assessing potential availability during design phase.* ***General comment:*** *Cost and performance implications are not fully understood, recycling into new glass product may be of higher value than use in construction. Refer NZTA guidance on recycled and alternative materials for transport infrastructure and NZTA M04 Specification and NZTA M15 Specification.*
Other recycled materials as basecourse aggregate	ⓘ 1	✔	✔				⚑ 2	***1.*** *Some minor requirements for Glenbrook melter slag, otherwise no additional restrictions, but must be approved by appropriate regional council* ***2.*** *Designers may face challenges in assessing potential availability during design phase.* ***General comment:*** *Examples include, crushed rail ballast, Glenbrook melter slag. Will require further investigation to understand material/cost and carbon saving benefits. Refer NZTA guidance on recycled and alternative materials for transport infrastructure and NZTA M04 Specification.*
Recycled and alternative materials as sub-base aggregate	ⓘ 1	✔	✔					***1.*** *Generally, there is no upper limit for recycled material content. Local specification using recycled material other than glass will need to be approved by the appropriate regional council.* ***General comment:*** *Refer NZTA guidance on recycled and alternative materials for transport infrastructure.*
★ Local sources for imported site materials	✔	✔		✔				***General comment:*** *Updated NZTA M04 Specification for basecourse aggregate allows a wider range of rock materials to be used, reducing processing and transportation costs and associated emissions. NZTA M03 specification for sub-base materials is also expected to be published with similar philosophy.*
★ Recycled asphalt millings for site roads and laydowns	✔	✔	✔	✔				

CASE STUDIES

Christchurch Southern Motorway: Recycled crushed concrete as sub-base aggregate

The project maximised the use of RCC, with 122,000 tonnes of RCC utilised. A 200mm thick subbase was constructed using AP65 RCC,

Papakura to Drury, Auckland: Locally sourced aggregate

Additional testing was carried out to show that local Drury aggregate met specification requirements. Compared to Glenbrook Quarry, this alternative sourcing option reduced embodied emissions from transport by 67%. This choice also led to a cost-neutral outcome.

NZTA M04 Specification: Locally sourced aggregate

NZTA has recently published their updated M4 Specification for basecourse aggregate which provides for a range of material quality, or Class, depending on pavement loadings. The specification updates include allowing testing to support the selection and use of local materials.

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Fuel and energy use

	Fuel and energy use	**Technical** NZTA approved	**Uptake** Common in NZ context	**Quality** Unlikely to require further trials	**Commercial** Likely cost neutral or cost saving	**Programme** Low impact on programme	**Regional** Available nationwide	**Supply Chain** Low supply chain complexity	
★	Cut and fill balancing to limit imported/exported materials	✔			✔				
★	Re-use site won materials/ soil/other organic matter i.e., duff	ℹ 1	✔	⚑	✔				***1.*** *Contaminated material would require further consideration* ***General comment:*** *Often driven by geotechnical considerations rather than contamination. May require increased corridor/designation width.*
★	Local sources for imported site materials	✔	✔		✔				
★	Construction light vehicles hybrid or electric	✔	✔		⚑ 1			⚑ 2	***1.*** *Higher capital cost, WOL cost saving* ***2.*** *Potential supply chain constraints.*
	Hybrid or electric mobile construction equipment	✔	⚑		⚑ 1			⚑ 2	***1.*** *Higher capital cost, WOL cost saving* ***2.*** *Potential supply chain constraints.*
	Hybrid, electric or hydrogen trucks for materials transportation	✔	⚑		⚑ 1			⚑ 2	***1.*** *Higher capital cost, WOL cost saving.* ***2.*** *Potential supply chain constraints.*
	Biodiesel as a partial fuel blend	✔	✔					⚑ 1	***1.*** *Limited supply chain availability.*
★	Driver fuel efficiency training	✔	✔		✔			✔	
★	Diesel generators alternatives	✔	✔		✔				***General comment:*** *Examples include, electrification/grid connection or solar powered site equipment/lighting towers/offices or battery powered generators.*
	Digital and logistics modelling to reduce fuel use	✔	✔		✔				***General comment:*** *Examples include, construction management platforms that help manage field operations, and track materials or use of technology to support driver fuel training and behaviour change and activity planning software to support programming of works and operational efficiency.*

CASE STUDIES

O Mahurangi – Penlink, Auckland:

Spoil and surplus fill diverted from landfill: Sites were identified within the project area to retain 242,000m³ of material that would have otherwise been sent off-site. This achieved the targeted 100% spoil diversion from landfill, an estimated 380tCO_2e emissions reduction and cost savings due to reduction in fuel use.

Electric utes: Three electric utes were hired for the 7km new highway project site to test for practicality and usability. Having proven fit for purpose, additional electric utes have now been ordered for the project.

Hybrid, electric assisted and/or Tier 4 plant: The project is utilising hybrid, electric assisted and/or Tier 4 (emissions regulated) plant for bulk earthworks. With the use of Adblue, this equates to an estimated 10-15% fuel saving for the project.

Te ahu a Turanga - Manawatū Tararua Highway:

On site driver training: This project is implementing initiatives to educate drivers on efficient fuel use and awareness of the impact of tyre pressure on energy consumption. These initiatives are estimated to reduce emissions by around 1500tCO_2e for the project and save cost due to reduction in fuel use.

SH1 Whangārei to Wellsford, Northland: Hybrid excavator

A 33T Komatsu HB335L hybrid excavator was trialled for construction works. This has been estimated by the manufacturer to reduce fuel consumption by 20%.

SH25A Taparahi Slip Remediation, Coromandel: Battery-powered generator

The project used a battery-powered generator in place of diesel generator to power the site office. This saved around 510 kgCO2e per day.

Glossary of Terms

Term	Definition
Bio Bitumen	Alternative to traditional fossil-fuel-based bitumen, derived from renewable sources such as vegetable oils, lignin, or other plant materials. Can be used as partial or full replacement for traditional fossil-fuel-based bitumen.
Embodied emissions	GHG emissions resulting from manufactured products, materials or fuel used in construction of the built environment.
Enabled emissions	GHG emissions that occur from third party use of infrastructure (for example tailpipe emissions as a result of vehicle kilometres travelled (VKT))
EPD	Environmental Product Declaration (EPD) is a standardised document that communicates a products environmental impact.
Fly ash/GGBS	Fly Ash is a by-product of coal combustion and GGBS (Ground Granulated Blast Furnace Slag) is a by-product of iron manufacturing. Fly ash and GGBS are used in concrete as supplementary cementitious materials (SCMs). GGBS and fly ash are well understood as cement replacement materials in concrete and are in high demand globally. Alternative lower carbon SCMs are less well understood but will be required longer term as availability of fly ash and GGBS decreases.
GHG emissions	GHG emissions refers to gaseous constituents of the atmosphere, both natural and anthropogenic, that absorb and emit radiation at specific wavelengths within the spectrum of thermal infrared radiation emitted by the Earth's surface, the atmosphere itself, and by clouds. This property causes the greenhouse effect. Water vapour (H_2O), carbon dioxide (CO_2), nitrous oxide (N_2O), methane (CH_4) and ozone (O_3) are the primary greenhouse gases in the Earth's atmosphere. GHG emissions are measured in kgCO2e or tCO2e, see definition below. GHG emissions are also referred to interchangeably as carbon emissions in this guide.
GWP	Global Warming Potential (GWP) is the environmental impact of a gas, which could be a combination of different greenhouse gases, expressed as the equivalent amount of carbon dioxide that would create the same amount of global warming, measured in kgCO2e or tCO2e, see definition below.
HiLab	High strength Low fines Aggregate Base.
Kaitiaki	A person, group or being that acts as a guardian, protector and conserver.
LCA	Life Cycle Assessment, also known as life cycle analysis, is a methodology for assessing environmental impacts (including carbon emissions) associated with all the stages of the life cycle of a commercial product, process, or service.

Term	Definition
Lignin	Lignin is complex organic polymer that is pulp and paper-by-product that can be used in roading applications as a bitumen replacement.
NbS	The UN defines Nature based solutions, or NbS, as "actions to protect, conserve, restore, sustainably use and manage natural or modified terrestrial, freshwater, coastal and marine ecosystems, which address social, economic and environmental challenges effectively and adaptively, while simultaneously providing human well-being, ecosystem services and resilience and biodiversity benefits."
Operational emissions	GHG emissions resulting from the energy use of an asset or building during its lifetime of operation.
Pozzolan	Natural pozzolans are primarily alumino-silicates or amorphous silica that react with hydroxyl ions in concrete to produce secondary pozzolanic reactions. Examples include pumice, amorphous silca and volcanic glass.
RAP	Reclaimed Asphalt Pavement (RAP) is the term given to removed and/or reprocessed pavement materials containing asphalt and aggregates. These materials are generated when asphalt pavements are removed for reconstruction, resurfacing, or to obtain access to buried utilities. When properly crushed and screened, RAP consists of high-quality, well-graded aggregates coated by asphalt cement.
RCC	Recycled Crushed Concrete
SAC	Structural Asphalt Pavement
SCM	Supplementary Cementitious Materials (SCMs) are typically sourced from industrial wastes such as fly ash, ground granulated blast-furnace slag (GGBS), silica fume or from natural materials such as pozzolans.
SME	Subject Matter Expert
Tall Oil Pitch	Tall Oil Pitch (TOP) is a plant-based, semi-viscous distillate derived from crude tall oil, obtained during the wood pulping process. It can be utilised as a bitumen replacement in road construction applications.
CO2e, kgCO2e, tCO2e	Not all greenhouse gases warm the atmosphere equally, some gases (such as methane) have a greater global warming potential, or warming effect, than carbon dioxide. To account for this, the term CO2e is used and means that greenhouse gases other than carbon dioxide can be converted, or normalized, to the equivalent amount of CO2, based on their relative contribution to global warming. This provides for a single, uniform means of measuring emissions reductions for multiple greenhouse gases. CO2e is typically measured in tonnes (t) or kilograms (kg).

References

The information provided in this guide relies mainly on reports or research commissioned by NZTA, published information from various industry bodies and knowledge and inputs from NZTA and Beca Subject Matter Experts.

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