Sunfield Master Planned Community

Sustainability and GHG Emissions Assessment

Stantec

Prepared for:
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Executive Summary

Winton Land Limited (WLL) intend to submit a substantive application to the New Zealand Government for the proposed Sunfield development as a listed project under the Fast-track Approvals Act. The development is located in Takanini, comprising a 244.5-hectare parcel of land to be transformed into a unique master planned community. The community design explores an innovative, integrated approach to urban development, moving away from a reliance on private motor vehicles, towards a future-thinking car-less, human-centred, walkable, connected and resilient community. The proposed development embraces integrated urban planning and nature-based solutions, and represents a significant opportunity to reshape traditional master planned community design, while simultaneously encouraging lower carbon living and behaviour change. In addition, 27 hectares of land will be dedicated to open space, recreation areas, stormwater mitigation, and ecological restoration, enhancing biodiversity, climate resilience, and overall sustainability outcomes for the precinct.

Sunfield will facilitate and encourage active and public transport, community connectedness, connection to nature and a modal shift away from private vehicle reliance, while prioritising integrated nature-based solutions and community resilience. Sunfield's masterplan is designed to minimise reliance on private vehicles, with only 10% of residential dwellings allocated a car park (340 in total) and an additional 10% (340 car parks) provided within the retail hub. With just 10% of households expected to own a private vehicle, the development prioritises sustainable transport options, including the Sunbus—a solar-powered bus that will provide convenient, zero-emission transport throughout the precinct. This approach is expected to significantly reduce private vehicle trips and associated Greenhouse Gas (GHG) emissions, reinforcing Sunfield's commitment to low-impact, sustainable living.

The significance of a car-free design is highlighted the fact that transport emissions are the fastest growing source of GHG emissions in New Zealand, accounting for 20% of New Zealand's overall GHG emissions, with nearly 70% of these emissions stemming from cars and light vehicles[1]. In addition, it is estimated that GHG emissions from urban travel by private car contributes approximately one-third to the average household GHG footprint[2]. Sunfield's inherent sustainable design measures and facilitation of behaviour change through eliminating private vehicles within the community, will contribute towards GHG emission reduction targets.

Stantec have undertaken a Sustainability and GHG emissions assessment to assess Sunfield's alignment and contribution towards global objectives and trends in sustainable community development, and relevant national and regional GHG policy. This assessment is supported by a high-level GHG emissions assessment, (appropriate to the level of detail available at this design stage), including consideration of key identified emissions sources (where detail is available), in addition to the low carbon design measures inherently embedded within the current design.

[1] Ministry of Transport, 2020
[2] Australia's Unintended Cities: The Impact of Housing on Urban Development, 2012

The outcomes of the sustainability assessment are summarised in Section 4, with further detail provided in Appendix A.1, including mapped alignment of Sunfield's design elements against the identified objectives, trends and policies. The GHG emissions assessment is detailed within Section 5, providing an early analysis of the developments' possible range of capital and operational GHG emissions, based on information available at this early design stage. The results indicate that the capital (upfront) emissions associated with the construction of commercial and residential buildings account for the largest proportion of the overall GHG footprint, therefore presenting the greatest opportunity to target reductions. It is acknowledged that typically transport infrastructure is a significant contributor to capital emissions in a community development, however, Sunfield's car-less design concept significantly reduces the requirement for transport infrastructure and hardstand throughout the community, and it is anticipated that the capital emissions associated with transport infrastructure will be reduced compared to a traditional community development.

Effects were subsequently identified and assessed within Section 6 based on each GHG emissions source and their associated potential impacts (positive and negative). Bespoke qualitative assessment criteria informed the *Assessment of Effects*, in order to assess and evaluate the magnitude of each effect on a rating scale ranging from *insignificant impact* to *significant impact* to *positive impact*. The effects assessment within Section 6.2 determined there to be likely no *significant* adverse effects associated with the capital and operational GHG emissions, with several positive potential effects identified, as informed by the current design.

Recommendations have been developed in alignment with a mitigation hierarchy and are presented within Section 7, in order to inform future strategic decision-making at subsequent design stages, and it is anticipated that these recommendations will be further considered and integrated as part of the detailed design development process.

Acronyms / Abbreviations

ACP - Auckland Climate Plan 2020

AFDS - Auckland Future Development Strategy 2023-2053

AUP - Auckland Unitary Plan 2011

CCMP - City Centre Masterplan

CCR - Climate Change Response Act 2002

ERP - Aotearoa New Zealand Emissions Reduction Plan / Te hau mārohi ki anamata - Aotearoa New Zealand's first Emissions Reduction Plan, 2022

GHG - Greenhouse Gas

GSC - Global Sustainability Community

HAT - Healthy Auckland Together

IMP - Iwi Management Plan, 1995

LGWM - Let's Get Wellington Moving

NPS - National Policy Statement for Freshwater Management 2020

NPS-UD - National Policy Statement on Urban Development, 2020

RMA - Resource Management Amendment Act 2020

SC - Social Cure

TERP - Auckland Transport Emissions Reductions Plan 2020

WLL - Winton Land Limited

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1 Introduction

1.1 Scope and Objective

This Sustainability and GHG Assessment Report aims to assess Sunfield's alignment and contribution towards global sustainable community development trends and relevant national and regional GHG policy. The structure of the report is outlined by the following sections:

- Global Sustainability Trends and Targets (Section 2)
- GHG Emissions Policy Landscape (Section 3)
- Alignment with Global Sustainability Trends and National Policy (Section 4)
- GHG Emissions Assessment (Section 5)
- Assessment of Effects (Section 6)
- Recommendations (Section 7)

1.2 Summary of the Development

1.2.1 Sunfield Overview

WLL is proposing to deliver Sunfield, a unique, forward thinking master planned community development located in Takanini. The proposed community comprises 244.5-hectares of land, with the objective to be a 15-minute sustainable neighbourhood, designed to enable car-less living and provide residents access to most, if not all, resident needs within a short walk or bike ride from their home, including schooling, employment, medical services, restaurants and bars, recreational spaces, retail, and food supplies. The development includes approximately 3,400 individual homes, 3 retirement villages, employment, retail, healthcare and education precinct, a 7.6 town centre, a school, retail hubs throughout the community, and 27.7 hectares of open spaces, green links, recreation parks and reserves and ecological offsets, including extensive restoration and native planting of the core stream and wetland network. Upon completion, Sunfield will comprise:

- 3,800 healthy homes, consisting of 3,200 individual homes and 3 retirement villages of approximately 600 independent living units and care beds.
- 460,000 sqm of employment, retail, healthcare and education buildings.
- Permanent jobs for over 11,000 people.
- A 7.6-hectare town centre.
- One school.
- A further 5 retail hubs located throughout the community.

- 27.7 hectares of open spaces, green links, recreation parks and reserves and ecological restoration.
- An extensive restoration and native planting of the core stream and wetland network.
- A community designed to enable “car-less” living.
- The establishment of the Sunfield renewable solar energy network for the community.
- The Sunbus autonomous electric shuttle fleet.

Sunfield’s eight core design principles are illustrated in Figure 1 below:

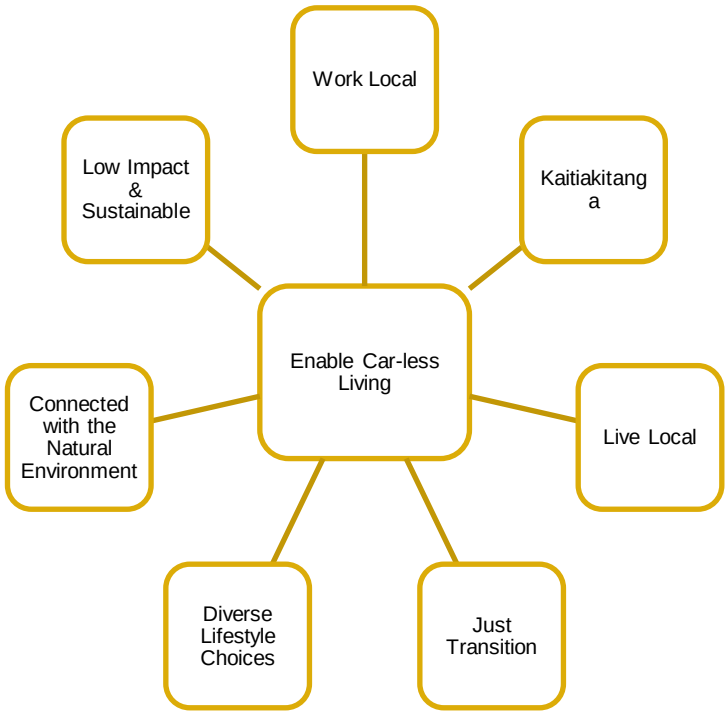


Figure 1 Sunfield Design Principles

As illustrated in Figure 2 below, the development sits between the rapidly urbanising and expanding neighbourhoods of Takanini and Papakura, providing a logical expansion of the adjacent existing and established urban areas.

Figure 2 Aerial view of the development

1.2.2 Sustainability in Design

The proposed Sunfield design inherently embeds sustainable low carbon and resilience strategies that will contribute to a minimised emissions footprint when compared to a baseline (scenario for what GHG emissions would have been in the absence of measures aiming to reduce emissions). These measures include hard (engineering) and soft (nature-based) solutions, ranging from the 15-minute neighbourhood and car-less design concept through to revegetation and restoration of the existing natural environment, enhancing the ecological value and resilience of the existing site.

The key sustainable and low carbon design measures embedded within the current proposed design are outlined below in Table 1, mapped against the eight core Sunfield design principles.

Table 1 Sustainable Design Measures: An Overview

Core Principle	Description	Sustainable Design Detail
Enable Car-less Living	Neighbourhoods and dwellings designed without a “private car”	• 15-minute neighbourhood design and close access to local amenities • Comprehensive network of walking, cycling and public transport links including the Sunbus EV fleet • Car-less community design • Access to public and active transport facilities

		• Only 10% of the residential dwellings will have a carpark (340 in total) and that a further 10% (340 carparks) will be provided in the hubs.
Live Local	15-minute neighbourhood and the creation of walkable neighbourhoods	• Integrate social, recreational, health, aged care, education, commercial retail activities, and employment close to or within residential areas
Work Local	Embed significant employment opportunities close to home and easily accessible by walking, cycling, and public transport.	• 460,000 sqm of employment, retail, healthcare and education buildings. Permanent jobs for over 11,000 people.
Kaitiakitanga	The Māori world view of kaitiakitanga acknowledges the responsibility and the protection of the natural environment by Mana whenua.	• An extensive restoration and native planting of the core stream and wetland network. • Wai Mauri Stream Remediation. • Water Sensitive Urban Design ("WSUD")
Low Impact and Sustainable Living	Sunfield has a vision to be New Zealand's lowest carbon community, positively contributing to the transition to a low carbon New Zealand.	• A dramatic reduction in car dependence and promotion of healthier transport options • A consolidated approach to stormwater management for improved water quality and resilience • The use of clean renewable energy (Sunfield renewable solar energy network) • Integration of community gardens within the community and other initiatives that allow for more sustainable lifestyle choices • Comprehensive network of walking, cycling and public transport links including the Sunbus EV fleet • All homes / buildings are 100% electric • Water storage and supply via rainwater collection from the hub and village rooftops
Just Transition	Sunfield supports a just transition to a low carbon economy by offering a low carbon lifestyle with healthy homes that are more affordable to purchase, cheaper to run and easily accessible whether it's on public or shared transport, by foot or bike.	• The use of clean renewable energy (Sunfield renewable solar energy network) • Reducing the need for personal cars • Reduced new infrastructure requirements (less roads) • Optimisation of residential home design through reducing the need for a garage • Reduced living costs related to owning and servicing a car, and

		reduced electricity costs from solar energy proposed to make up most of the energy supply
Diverse Lifestyle Choices	Establish diverse and thriving communities by providing a range of housing options that respond to differing needs.	• Provide a range of housing typologies and ownership models • Provide for consolidated approaches to communal space
Connected with the Natural Environment, encouraging Biodiversity	Closely connected to the concept of kaitiakitanga the enhancement of native habitats, waterways and links to regional ecological connections become significant aspects that contribute to the identity of the community	• Restoration of the existing waterway • Stormwater management prioritising improved water quality and resilience, recreation, movement networks, natural features, public and private outdoor spaces • Prioritising nature-based solutions including extensive stormwater management systems consisting of predominantly open watercourses and riparian planting • Provision of community gardens • Creation of green links, recreation parks and reserves and ecological restoration, including extensive restoration and native planting of the core stream and wetland network • WSUD strategy incorporates ground water recharge to the peat subgrade soils, reduced impervious area (due to reduced requirements for vehicle-related hardstand) and large-scale attenuation of stormwater

2 Global Sustainability Trends and Targets

2.1 Global Trends in Sustainable Development

Global trends in sustainable development have been categorised into seven themes as illustrated in Figure 3 below.

Figure 3 Global Sustainability Trends

As outlined, these key themes include Post-Pandemic Localisation, Liveability and Human Centred Design, Climate Mitigation & Adaptation, Connection and Liveability, Healthy and Active Living, Biodiversity and Ecological Conservation and Resilient and Future Focussed. Each of these global themes are explored in further detail in the following sections.

2.1.1 Urban Planning and Post-Pandemic Localisation

Integrated Urban Planning

From a sustainability perspective, 'integrated urban planning' means crafting urban spaces that harmoniously balance environmental, social, and economic dimensions. This approach ensures that development aligns with the existing urban fabric and natural ecosystems, while prioritising the reduction of carbon emissions and fostering a transition to renewable energy. By integrating low-carbon development principles, urban planning can mitigate climate change impacts through the design of energy-efficient buildings, sustainable infrastructure, and resilient public spaces. Additionally, it promotes connectivity and accessibility, enhancing liveability while safeguarding the environment for future generations.

The Untied Nations (UN) Environment Programme states that “Integrated planning is a powerful tool to ensure environmentally sensitive and just urban development. Sustainable and integrated urban design is a holistic approach that creates synergies by combining various aspects of city design and management, such as place-making, transportation, housing, health and biodiversity. This approach is an opportunity to move towards low-carbon and human-scale models of urban development and address jointly challenges of climate change, pollution, and biodiversity loss, while contributing to the achievement of the Sustainable Development Goals” (UN Environment Programme, 2024).

According to the The Hague Academy for local governance (2023), there are 5 key elements to integrated urban planning:

- the involvement of key stakeholders
- well-formulated and sustainable objectives
- planning that is connected to a larger geographic area (not just a neighbourhood)
- the involvement of institutional and financial mechanisms
- a resilient design that leaves space to respond to unforeseen situations, as projects grow in complexity and in time to complete.

Today, more than half of the world's population lives in urban areas. In New Zealand, over 86% of its population live in urban areas, according to a 2023 census (Statista, 2023). Auckland was the fastest growing region in 2023, and has an expected 21% growth adding 297,100 people by 2048 (Stats NZ, 2023). The need for integrated urban planning in Auckland is driven by its rapid population growth and the unique challenges associated with it. Auckland is home to about a third of New Zealand's population, and this proportion is projected to rise to 37% by 2048. The city's population is expected to surpass 2 million by the early 2030s, fuelled by both natural increase and significant immigration. This growth is accompanied by increasing ethnic diversity, an ageing population, and a rise in younger residents, all of which add complexity to urban development (Auckland Council, 2023; Stats NZ, 2021).

Post-Pandemic Localisation

Historical global disruptions have consistently reshaped urban development, from London's cholera outbreaks in the 1850s, which led to its comprehensive sewage system, to post-World War II European governments' initiatives that emphasized inclusive residential rebuilding and urban nature protection. The COVID-19 pandemic has similarly triggered a transformation towards more liveable, inclusive, and greener cities. This shift is evident in the US and Europe, where major cities saw rent decreases, while suburban and smaller urban areas experienced growth due to the rise of hybrid work models and changing migration patterns. A survey completed in 2021 demonstrated this effect, with a trend in New Zealanders 'de-urbanising' and choosing to move away from city centres to smaller urban and suburban areas, with 7 out of 13 city centres showing an internal migration flow, to smaller urban and suburban areas (Infometrics, New Zealand 2021).

The shift towards localisation has been strengthened by data showing increased local living and working patterns, leading to the rise of the '20-minute city' concept, which aims to create more balanced and equitable urban areas. A recent global survey stated that 1 in 5 workers are working remotely (Forbes, 2024) The COVID-19 pandemic has highlighted the need for integrated, accessible, and equitable public and private spaces, with new developments like those in Wainui, New Zealand, offering opportunities to design inclusive communities from the start. These efforts align with the United Nations' "building back better" initiative, focusing on creating a disability-inclusive, accessible, and sustainable post-pandemic world.

A recent survey completed by Stats NZ (2024) demonstrated that the number of New Zealanders working from home (WFH) raged from 7% to 30%, depending on what industry they were involved with. Information media, telecommunications, professional, scientific and technical services as well as financial and insurance services had the most amount working from home (23% to 30%) with healthcare having the least (7%). Auckland and Wellington have the higher WFH percentages than

other parts of New Zealand (Figure 4). This shift underscores the need for urban planning to focus on developing inclusive, sustainable communities that support these changing work patterns. New developments must consider the growing demand for local amenities, public spaces, and infrastructure that cater to a workforce that is increasingly decentralized and prioritizing quality of life over proximity to traditional urban centres (RNZ, 2023; Te Kawa Mataaho, 2023).

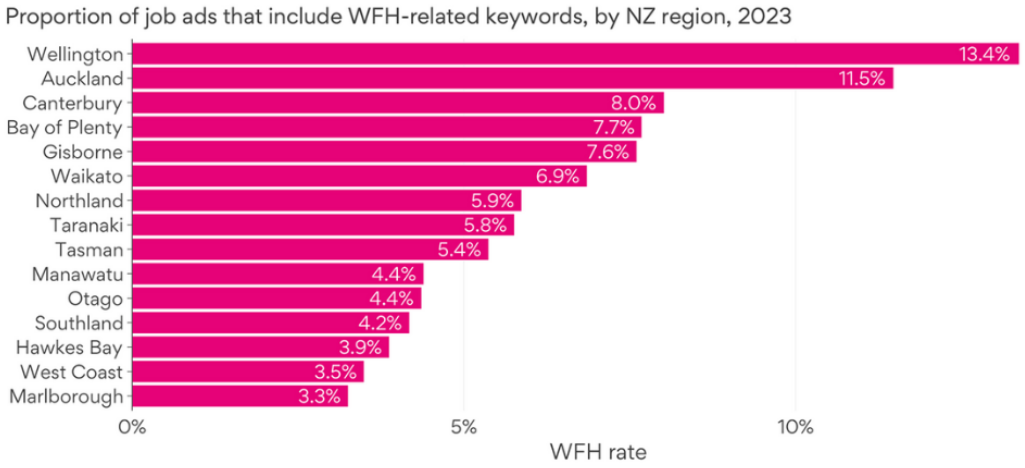


Figure 4 Working from home (WFH) rates across New Zealand (SEEK, 2024)

This post-pandemic location has influenced new residential development design in the following ways:

- **Hybrid Work Accommodations**: Designs include dedicated home office spaces and high-speed internet infrastructure to support remote work.
- **Local Amenities**: Increased focus on integrating local amenities such as parks, shops, and healthcare facilities within walking distance to reduce the need for travel.
- **Green Spaces**: Emphasis on creating abundant green spaces and recreational areas to enhance residents' well-being and provide outdoor activity options.
- **Sustainable Transport**: Implementation of sustainable transport options like bike lanes and pedestrian-friendly pathways to promote local commuting.
- **Mixed-Use Developments**: Development of mixed-use spaces that combine residential, commercial, and community functions to create self-sufficient neighbourhoods.
- **Affordability and Accessibility**: Designing affordable housing options that cater to a diverse range of incomes and accessible features for people with disabilities.
- **Community Engagement**: Incorporation of communal spaces to foster social interactions and build a sense of community among residents.
- **Environmental Sustainability**: Adoption of environmentally sustainable practices and materials in construction to reduce the carbon footprint of new developments.
- **Flexible Living Spaces**: Designing flexible living spaces that can adapt to changing needs, such as accommodating remote work or multi-generational living.

- **Proximity to Nature**: Strategic placement of developments near natural landscapes to provide easy access to nature and outdoor activities.
- **Health and Wellness**: Inclusion of features that promote health and wellness, such as fitness centres, walking trails, and wellness programs.
- **Resilient Infrastructure**: Building resilient infrastructure that can adapt to future disruptions, ensuring long-term sustainability and liveability.

2.1.2 Human-Centred Design

Human-centered design (HCD) is an approach to problem-solving that prioritises the needs, experiences, and behaviours of people throughout the design process. It involves deeply understanding the target users, creating solutions that are tailored to their needs, and iteratively testing and refining designs based on feedback. This method is particularly effective in creating solutions that are not only functional but also meaningful and accessible to the end-users.

In the context of sustainability and urban planning, HCD ensures that cities and communities are designed with the well-being of residents at the forefront. It emphasizes creating environments that are inclusive, equitable, and responsive to the diverse needs of different populations. By focusing on human needs, HCD in urban planning can lead to the development of more liveable, resilient, and sustainable urban spaces. This approach aligns closely with sustainable development goals, such as reducing carbon footprints, promoting walkability, and integrating green spaces, all while ensuring that these initiatives meet the actual needs and preferences of the community.

Walkability

Walkability has become an essential focus in urban planning due to its significant impact on health, environmental sustainability, and quality of life. Globally, there has been a growing trend towards incorporating walkability into urban design, with cities increasingly using it as a key metric in planning. This is evident in the development of guidelines such as those by New Zealand's Waka Kotahi, which provides comprehensive pedestrian network guidance aimed at creating walkable communities. Transportation accounts for about 21% of New Zealand's total GHG emissions (Ministry of Transport, 2022). New Zealand's 'The Decarbonising Transport Action Plan 2022 -2025' highlights the need to design spaces "to make it easy to get around without a car" to help decrease the GHG emissions related to transport.

The 20-minute city concept is a forward-thinking urban planning model that promotes the development of walkable, multifunctional neighbourhoods where essential services, amenities, and green spaces are accessible within a 20-minute walk or bike ride from home. This approach aims to reduce carbon emissions, lessen car dependency, and enhance quality of life by integrating diverse land uses, housing types, and public transport. Unlike traditional car-centric urban planning, which separates business, entertainment, and residential zones, the 20-minute city fosters hyper-localization, bringing work and daily needs into closer proximity, thus reducing the need for long commutes and encouraging sustainable, community-focused living. This concept can be seen in The City of Melbourne, which has been actively working on creating a 20-minute city framework to ensure that residents can access daily needs within a 20-minute walk or bike ride (City of Melbourne, 2024a). Paris has been advancing its "Ville du Quart d'Heure" (15-Minute City) concept under Mayor Anne

Hidalgo, aiming to decentralize city life and reduce reliance on cars (World Resources Institute, 2023). Portland (Oregan, USA) is working on its own version of the 20-minute city, incorporating elements into its broader urban planning and transportation strategies (Simon, 2022).

Car-less design

Since the mid-20th century, residential developments in Australia, New Zealand, and much of the world have prioritised cars in their design. As cars became widely available and affordable, urban planners centred neighbourhood layouts around car access and convenience. Roads, extensive parking, and houses with garages became the standard, creating car-focused neighbourhoods where pedestrian needs took a back seat. This car-dominant approach has left many urban areas defined by sprawling, multi-lane roads and limited pedestrian-friendly spaces, cementing the car as the primary mode of transport.

A growing trend in global sustainable urban planning is moving away from car-centric designs and focusing more on human-centred approaches that prioritise the needs of residents. Many new developments aim to reduce car reliance and create more liveable, pedestrian-friendly environments. Examples of car-free feature elements include omitting garages from residential buildings, providing communal car parks on the outskirts, and building extensive networks of pedestrian pathways and cycling infrastructure. This approach encourages community connections, active transport, and reduces the environmental impact of car use. The health concerns surrounding cars have further fuelled this trend, with the ground level ozone caused by nitrogen dioxide contributing to extensive air pollution which has been linked to premature death especially in heavily populated cities such as London (File, R, 2022). Low-traffic neighbourhoods (LTNs) are becoming more common in the UK, partly due to lockdowns and the popularity of 15-minute neighbourhoods, where residents can walk to essential amenities within 15 minutes. Inspired by Dutch urban planning, LTNs aim to “unbundle” traffic by separating motor vehicles from cycling and pedestrian paths, creating safer, more accessible spaces for walking and biking. London now has several of these LTNs, prioritising active transport and improving liveability. An example is the development Hill Rise in the UK which features ‘parking barns’. These adaptable spaces will initially serve as parking with electric chargers, car club spots, and community services like e-commerce collection and e-bike hire. Over time, these "parking barns" will transition entirely to community-oriented uses. Another example is Melbourne’s Nightingale residential development which ‘de-prioritises the car’ as part of its sustainable principles and places emphasis on car-share facilities, cycling routes and access to public transport.

With the rising cost of living, car-free apartment options are gaining popularity, with some developers offering apartments without parking at discounts of approximately AUD 100,000/ NZD 108,000. This trend aligns with increased public transport investment, growing car-sharing options, and shifts in planning regulations that no longer require minimum car spaces. Many councils now permit car-free developments, enabling homebuyers to save significantly. A recent RMIT study shows that some Melbourne households have more parking than needed, with nearly 14% of surveyed households having unused car spaces, underscoring the inefficiency of oversupply (Molloy, S, 2024).

A car-free neighbourhood provides significant environmental and sustainable benefits, including improved air quality and reduced greenhouse gas emissions due to less vehicle use. It lowers noise pollution and promotes healthier lifestyles through increased walking and cycling. With fewer paved areas, the neighbourhood experiences less heat absorption, mitigates the urban heat island effect, and enhances biodiversity through more green spaces. The reduced reliance on vehicles leads to

lower resource consumption and energy savings, while permeable surfaces improve stormwater management. Additionally, the walkable environment fosters community interaction and supports public transport, contributing to a more resilient urban transport network and enhancing overall climate resilience.

According to EPA short car trips under 1.6 kilometres account for approximately 16 billion kilometres annually in America. If people opted to walk for half of these trips instead of driving, assuming an average fuel economy of 9.4 litres per 100 kilometres (equivalent to 22 mpg) and fuel prices at USD 2.50 per gallon (approximately 4.17 New Zealand Dollars), around USD 575 million in fuel costs could be saved and reduce CO_2 emissions by about 2 million metric tons each year—equivalent to removing around 400,000 cars from the roads (EPA, 2024).

Figure 5 below summarises a study completed by (Ritchie, H, 2023), illustrating the carbon footprint of various travel modes. As displayed, diesel and petrol cars have a significantly greater GHG emissions footprint in contrast public transport (bus) and electric cars, and active transport.

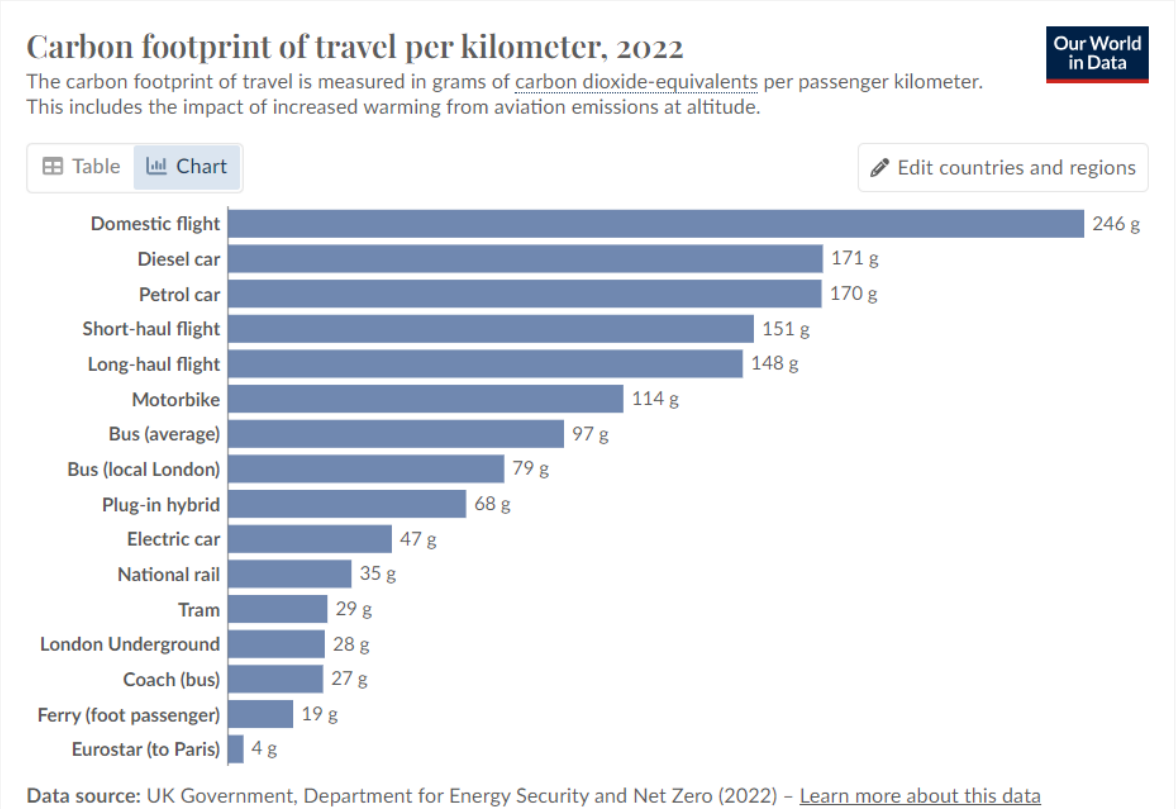


Figure 5 Carbon Footprint per mode of travel

Summary

New Zealand has been proactive in promoting liveable and human-centered urban design. The country's initiatives for walkable cities and liveable communities can be integrated within new community developments:

- **The New Zealand Urban Design Protocol**: This initiative by the Ministry for the Environment outlines principles for creating high-quality urban environments, emphasising walkability, accessibility, and sustainability.
- **Auckland's Liveability Agenda**: Auckland's plan includes developing neighbourhoods that support walking and cycling, providing local amenities and green spaces, and fostering strong community connections.
- **Wellington's Human-Centred Design**: Wellington has implemented human-centered design principles in urban planning, focusing on creating inclusive and accessible public spaces.

For new residential developments, the following principles of liveability and human-centered design can be adopted:

- **Walkable Neighbourhoods**: Design neighbourhoods to be walkable, ensuring essential services like shops, healthcare, schools, and parks are within a 20-minute walk or cycle. This reduces car dependency and promotes healthier lifestyles.
- **Mixed-Use Communities**: Develop mixed-use spaces that combine residential, commercial, and community functions to create self-sufficient neighbourhoods, reducing the need for long commutes.
- **Public Transport Integration**: Ensure robust public transport options are available to connect residents to broader metropolitan areas, promoting sustainable commuting options.
- **Green Spaces**: Incorporate ample green spaces and recreational areas to enhance well-being and provide areas for physical activities and social interactions.
- **Diverse Housing Types**: Include a variety of housing types to cater to different demographics, fostering inclusive communities.
- **Sustainable Design**: Utilise environmentally sustainable practices and materials in construction to reduce the carbon footprint of the development.
- **Community Engagement**: Encourage community participation in the planning and development process where possible, ensuring that the residents' needs and preferences are considered.

2.1.3 Climate Mitigation & Adaptation at a City Scale

Climate mitigation and adaptation at the city scale are crucial for addressing climate change and fostering sustainability. This approach focuses on reducing GHG emissions (mitigation) and preparing for the impacts of climate change (adaptation) through local policies, infrastructure improvements, nature-based solutions and community engagement to build resilience.

According to the Global Commission on Adaptation, investing $1.8 trillion globally in climate adaptation could generate $7.1 trillion in net benefits, including reduced damage costs and improved economic performance (Global Center on Adaptation, 2024). Cities that have focussed on this trend include Copenhagen, Denmark, which through Copenhagen's Climate Adaptation Plan focuses on increasing green spaces, improving stormwater management, and enhancing flood protection and

has managed to decrease their carbon emissions by 42% between 2005 and 2020, despite a growing population (Urban Development, 2024). Melbourne's "Climate Change Mitigation Strategy" focuses on voluntary measures to reduce emissions, including renewable energy adoption and energy efficiency improvements. Melbourne reduced its greenhouse gas emissions by 20% from 2005 to 2020 (City of Melbourne, 2024b).

Examples of Trends in Climate Mitigation and Adaptation

Global Shift Towards Electrification

Electric car sales keep rising and could reach around 17 million in 2024, accounting for more than one in five cars sold worldwide. According to the Global EV Outlook 2024 report by the International Energy Agency (IEA), electric vehicles accounted for approximately 16% of all new car sales worldwide in 2023, up from 14% in 2022 and 9% in 2021. This represents a significant increase from less than 5% in 2020 (International Energy Agency, 2024a). In New Zealand, EV adoption has also been gaining momentum (refer to Figure 5). In 2018, just over 1% of all new cars registered were electric, in 2023, the market share of fully electric and plug-in hybrid cars was over 27%. It should be noted that in 2024, EV market share decreased. The ending of rebates and the implementation of road taxes, matching diesel rates, caused a decline in demand. However, all new car purchases (irrespective of fuel type) have been significantly down in 2024 (EVDB NZ, 2024). Even with this decrease there is still a movement towards electrification "annual light EV registrations are expected to reach 62% of the market, and by 2035, 100% of cars entering the New Zealand fleet, both new and new second-hand imports, will be electric. This would mean that, by 2035, 38% of our total light vehicle fleet will be EVs" (EECA, 2024).

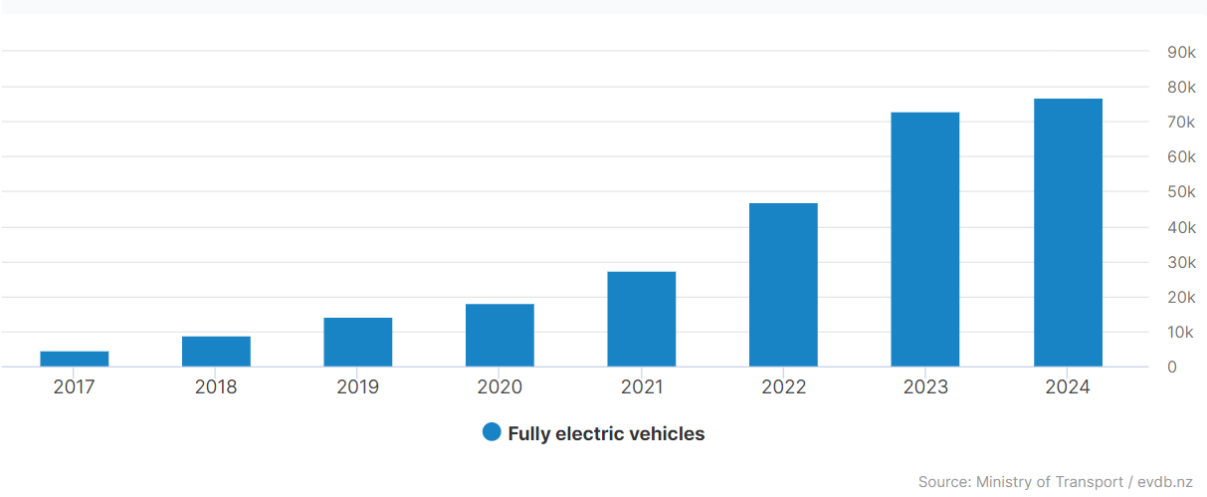


Figure 6 Increase in Electric Vehicles in New Zealand (EVDB NZ, 2024)

Decarbonising Public Transport

Public transport accounts for about 13% of global transport sector emissions, which in turn contributes roughly 20% of total global GHG emissions (International Energy Agency, 2024b). Electrification of public transport is critical for reducing urban emissions. Auckland Transport's Low Emission Bus Roadmap aims to transition the entire bus fleet from diesel to low-emission (electric and hydrogen) by 2040. International examples include London which has implemented a comprehensive approach to

decarbonizing its public transport system. Key measures include the introduction of the Ultra Low Emission Zone (ULEZ), which charges higher-emission vehicles to enter central areas, and the transition to electric buses (Transport for London, 2022). San Francisco has rolled out 100 electric buses and aims to convert its entire fleet to zero-emission by 2040 (SFMTA, 2024). As of early 2024, Paris has introduced over 200 electric buses and plans to increase this number significantly in the coming years. The city has set a goal to transition its entire bus fleet to electric or hydrogen by 2030 (Sustainable Bus, 2019).

Urban Heat Island (UHI) Mitigation

Efforts to mitigate the Urban Heat Island effect include increasing urban greenery, using reflective building materials, and designing cool roofs. Research indicates that increasing tree canopy cover by 10% can reduce surface temperatures by approximately 1.1°C(Rahman et al., 2024). Urban Green Infrastructure (UGI) is found to cool European cities by 1.07 °C on average, and up to 2.9 °C, but in order to achieve a 1 °C drop in urban temperatures, a tree cover of at least 16% is required (Marando et al., 2022).

Sustainable Urban Drainage Systems (SUDS)

SUDS are designed to manage rainfall and reduce flood risks through systems like rain gardens, swales, and detention basins. According to various studies, SUDS can reduce the risk of flooding by 30-50% in urban areas (Department for Environment Food & Rural Affairs, 2023). SUDS improve water quality by filtering pollutants from runoff before it reaches water bodies. They can reduce pollutants like sediments and heavy metals by up to 90% (Mmachaka et al., 2023).

Below is a summarised list of climate mitigation and adaptation trends that can applied to new residential developments, like Sunfield.

- **Green Infrastructure:** Integrating green spaces such as parks and green roofs to manage stormwater and reduce the Urban Heat Island (UHI) effect, enhancing urban cooling and resilience.
- **Electrification:** Promoting electric vehicle (EV) adoption by including EV charging infrastructure in new developments to lower greenhouse gas emissions from transportation.
- **Decarbonizing Public Transport**: Designing neighbourhoods with access to low-emission public transport options, such as electric and hydrogen-powered vehicles, to reduce urban transport emissions.
- **Sustainable Urban Drainage Systems (SUDS):** Implementing rain gardens, swales, and permeable pavements to manage stormwater, reduce flood risk by 30-50%, and improve water quality.

2.1.4 Connection & Liveability

Connection to People

Incorporating human connection into sustainable urban planning is crucial for fostering social well-being, resilience, and overall quality of life. As urban environments grow denser, the importance of

designing spaces that encourage social interaction and community building has become a global trend. Research consistently shows that social integration in urban settings can significantly enhance well-being; for instance, studies indicate that people living in socially connected communities experience a 15% increase in life satisfaction compared to those in more isolated environments (Diener, 2002). The World Health Organization (WHO) emphasizes the importance of social determinants of health, including social cohesion and community engagement, in their *Urban Health Equity Assessment and Response Tool (Urban HEART)*. This connection to others not only improves mental health but also contributes to the sustainability of cities by promoting inclusive, vibrant communities that can adapt and thrive in the face of challenges like climate change and urbanization.

Recent urban design projects around the world illustrate this trend. The Superkilen Park in Copenhagen, Denmark, is a prime example, designed to bring together the diverse local community through a blend of art, culture, and public space. This project has successfully fostered social cohesion and cultural exchange, enriching the lives of its users. Another example is the High Line in New York City, a linear park built on a disused railway track. The High Line has transformed into a social hub that connects people through its innovative design, integrating green space with public art and community events. These examples demonstrate how thoughtfully designed urban environments can enhance social connections, thereby improving the well-being of residents and contributing to the overall sustainability of cities.

Connection to Nature

The integration of nature into urban design is a growing global sustainability trend that not only enhances environmental resilience but also significantly improves the well-being of city dwellers. Urban developments that incorporate green spaces, natural landscapes, and biophilic design elements are increasingly recognized for their ability to reduce heat islands, improve air quality, and foster biodiversity. Moreover, studies have shown that access to nature in urban settings can boost mental health, reduce stress, and increase overall happiness. For example, research indicates that individuals who live near green spaces are 20% more likely to experience higher well-being compared to those who do not (White et al., 2019). This trend reflects a broader movement towards creating urban environments that are not only sustainable but also deeply connected to the natural world, supporting both ecological health and human well-being.

Recent urban planning projects demonstrate how this trend is being realized. The Bosco Verticale in Milan, Italy, is a pioneering example of biophilic architecture, featuring two residential towers covered in thousands of trees and shrubs. This design not only enhances biodiversity and reduces pollution but also creates a unique living environment that connects residents to nature, significantly improving their quality of life. Another example is Singapore’s Gardens by the Bay, a massive garden complex that combines sustainable technology with natural beauty. This project engages with the local culture and environment, promoting a deep connection to nature for both residents and visitors. In line with global sustainability practices, projects like these also emphasize the importance of engaging with Traditional Owners to identify and protect the cultural, ecological, and environmental typologies of the land, enriching the community’s connection to nature and ensuring that development respects and integrates local heritage and ecosystems.

Connection to Livelihood and Goods and Services

The sustainability trend of "Connection to Livelihood and Goods and Services" focuses on integrating key services and economic opportunities into urban planning to enhance community well-being and liveability. Cities that prioritize access to essential services, such as public transport, healthcare, education, and consumer goods, tend to rank higher in global assessments like The Global Liveability Index, which evaluates cities on factors such as stability, infrastructure, and culture. For instance, ensuring that residents have convenient access to local economic opportunities and community hubs through active and public transport fosters a socially cohesive and inclusive environment. This approach not only improves the quality of life but also supports sustainability by reducing reliance on private vehicles and promoting local economies. A relevant example is Melbourne, Australia, which consistently ranks high on the Global Liveability Index due to its well-developed public transport system, abundant green spaces, and strong local economy. In Melbourne, human-centred design solutions that enhance connectivity and access to services have significantly contributed to its high liveability and sustainability

Connection to Active and Public Transport

The global sustainability trend of connecting urban spaces to active and public transport is crucial in reducing carbon emissions and enhancing community well-being. Access to public transport significantly reduces reliance on private cars, cutting down on GHG emissions. For instance, studies show that cities with well-developed public transport systems can reduce carbon emissions by up to 30% as fewer residents rely on cars for daily commutes (UITP, 2019). Additionally, prioritizing active transport modes, such as cycling, further decreases emissions. Providing dedicated bike lanes can lower carbon emissions by an estimated 11%, as more people choose cycling over driving (ECF, 2011). This shift not only helps combat climate change but also improves air quality, reduces traffic congestion, and promotes healthier lifestyles.

Cities like Copenhagen and Bogotá have successfully integrated these principles into their urban planning. Copenhagen is renowned for its extensive cycling infrastructure, with over 62% of residents commuting by bike daily, significantly contributing to the city’s goal of becoming carbon-neutral by 2025. Bogotá, Colombia, has also embraced active and public transport through its TransMilenio bus rapid transit system and the creation of hundreds of kilometers of bike lanes. These efforts have led to a substantial reduction in traffic-related emissions and have made the city more accessible and inclusive. By prioritizing walkability, cycling, and public transit, both cities serve as models for how sustainable urban planning can enhance environmental sustainability while improving the quality of life for residents.

Specific Relevance to New Zealand

- **New Zealand Initiatives**:
    - **Healthy Auckland Together (HAT):** This coalition of health agencies, local government, and community organizations works to create environments that support healthy living. HAT focuses on increasing access to healthy food, promoting physical activity, and creating safe, vibrant public spaces. Their efforts contribute to improving the overall health and wellbeing of Auckland residents, making the city more liveable and attractive.

- **Auckland's City Centre Masterplan (CCMP)**: The CCMP aims to transform Auckland into a world-class city centre by improving public spaces, promoting sustainable transport, and enhancing the quality of life for residents. Key initiatives include expanding green spaces, creating pedestrian-friendly streets, and developing mixed-use neighbourhoods to reduce car dependency and improve accessibility.

Below is a summarised list of connection and liveability trends that can be applied to new residential developments:

- **Foster Social Interaction:** Design spaces that encourage community engagement and interaction, such as public parks, community centres, and mixed-use areas.
- **Incorporate Green Spaces:** Integrate parks, gardens, and natural landscapes to enhance environmental resilience and boost residents' well-being.
- **Promote Active Transport:** Develop infrastructure for walking and cycling, including sidewalks, bike lanes, and pedestrian-friendly routes.
- **Ensure Access to Public Transport:** Plan for efficient and accessible public transport options to reduce reliance on private vehicles and lower carbon emissions.
- **Support Local Economy:** Include spaces for local businesses and services to enhance economic opportunities and convenience for residents.
- **Engage with Traditional Owners:** Collaborate with local Indigenous communities to protect cultural and environmental aspects of the land.
- **Design for Accessibility:** Ensure that key services such as healthcare, education, and retail are within walkable distances or accessible by public transport.
- **Encourage Mixed-Use Development:** Plan for neighbourhoods where residential, commercial, and recreational spaces are integrated to reduce travel distances.

2.1.5 Healthy & Active Living

The trend of designing cities to promote healthy and active living is gaining momentum worldwide. According to a 2023 report by the World Health Organization (WHO), approximately 70% of cities globally have implemented or are planning to incorporate aspects of healthy urban design, such as walkability, active transport, and open green spaces (WHO, 2016). Key elements include public open green spaces, local parks, recreational facilities, active transport connections, and walkability. The Global Sustainability Community (GSC) tool rewards developments that provide access to these amenities within communities.

Cities that incorporate healthy and active living elements can significantly reduce GHG emissions by lowering reliance on cars and promoting active transportation. According to a 2022 study by the International Council on Clean Transportation (ICCT), cities with high walkability and active transport infrastructure could reduce transportation-related CO_2 emissions by 10-20% by 2030 (ICCT, 2024). The "Superblocks" initiative (urban areas to prioritize pedestrians and cyclists, limiting car access and increasing green spaces) in Barcelona is projected to reduce CO_2 emissions by 42,000 tCO_2e

annually, while Copenhagen's focus on cycling infrastructure contributes to the city's goal of reducing transport-related emissions by 50,000 tCO_2e by 2025.

Key Attributes of Healthy and Active Living

- **Public Open Green Spaces and Local Parks**: Ensuring access to green spaces and local parks is crucial for residents' physical health and mental well-being. These areas provide opportunities for outdoor activities and social interaction, fostering a sense of community.
- **Recreational Facilities**: Facilities such as fitness centres, sports complexes, and community recreation areas encourage physical activity and healthy lifestyles. These amenities cater to diverse interests and age groups, promoting inclusive community engagement.
- **Active Transport Connections and Facilities**: Developing extensive networks of walking and cycling paths encourages active transport, reducing reliance on cars. Providing infrastructure such as bike racks, safe crossings, and pedestrian-friendly routes makes active transport more accessible and appealing.
- **Walkability**: Designing walkable neighbourhoods where residents can easily access daily necessities, services, and social activities on foot. Enhancing walkability improves physical health, reduces traffic congestion, and lowers carbon emissions.

Specific Relevance to New Zealand

- **New Zealand Initiatives**:
    - New Zealand cities, including Auckland, are increasingly focusing on creating walkable, liveable communities with integrated green spaces and active transport options.
    - The New Zealand Government and local councils are investing in infrastructure to support cycling and walking, aiming to make these modes of transport more attractive and safer for residents.
- **Auckland's Active Transport Goals**:
    - Auckland Transport's initiatives include expanding the city's cycling network and enhancing pedestrian pathways to promote active living.
    - The city's plans aim to reduce car dependency, improve public health, and create more vibrant communities.

2.1.6 Biodiversity & Ecological Conservation

The global trend in urban development increasingly emphasizes biodiversity and ecological conservation as essential components of sustainable design. Incorporating these elements into urban planning helps protect and enhance natural environments, supporting both ecosystem health and human well-being. A recent study highlights that 70% of new urban design developments now integrate biodiversity considerations into their frameworks, reflecting a growing commitment to ecological sustainability (Rega-Brodsky et al., 2022). Additionally, major sustainable design

frameworks such as Green Star, BREEAM, and LEED have recognised the importance of biodiversity, with over 60% of these frameworks now including criteria related to ecological conservation (WGBC, 2020).

Ecological conservation is crucial for maintaining the balance of natural systems, which directly impacts urban environments and human health. The World Health Organization emphasizes that biodiversity loss can significantly affect human health, underscoring the importance of preserving diverse ecosystems. Urban areas that incorporate green infrastructure and biodiversity features can see substantial benefits, including a 20% reduction in air pollution and improved mental health outcomes for residents (Jennings et al., 2021). By protecting and enhancing natural habitats within urban settings, cities can promote ecological resilience and contribute to the overall sustainability of urban development, aligning with global goals for environmental conservation and community well-being.

Below is a list of emerging trends in New Zealand and globally surrounding Biodiversity and Ecological Conservation.

- **Urban Biodiversity Initiatives**:
    - In New Zealand, the *Auckland Urban Ngahere (Forest) Strategy* aims to increase urban tree canopy cover, improve biodiversity, and enhance residents' connection to nature. The strategy includes planting native trees, protecting existing vegetation, and creating green corridors that connect urban areas to larger natural reserves.
    - Globally, cities like Singapore have implemented extensive urban greening programs, integrating vertical gardens, green roofs, and nature parks into urban planning. This approach not only supports biodiversity but also enhances urban resilience to climate change.
- **Community Involvement in Conservation:**
    - The *Predator Free 2050* initiative in New Zealand involves local communities in efforts to eradicate invasive predators that threaten native wildlife. By fostering community participation in conservation activities, this program enhances biodiversity and strengthens community ties.
    - Similarly, global examples like the *City Nature Challenge*, an annual event where cities compete to document urban biodiversity, engage residents in citizen science and raise awareness about local ecosystems.
- **Sustainable Land Use Planning:**
    - In New Zealand, the *Te Ture Whaimana o Te Awa o Waikato (Vision and Strategy for the Waikato River)* guides land use planning to protect and restore the health and wellbeing of the Waikato River and its catchment. This approach integrates cultural values and environmental sustainability into development practices.
    - Internationally, the *European Union's Biodiversity Strategy for 2030* sets ambitious targets for protecting natural habitats and restoring degraded ecosystems, influencing land use planning and development across member states.

Below is a list of 5 actionable items for incorporating biodiversity and ecological conservation into a new urban development:

- **Implement Urban Greening Initiatives:** Develop green infrastructure such as vertical gardens, green roofs, and nature parks to enhance biodiversity and improve urban resilience. This aligns with global trends and supports ecological health.
- **Increase Native Vegetation:** Plant native trees and create green corridors to connect urban areas with larger natural reserves. This approach, as seen in Auckland's Urban Ngahere Strategy, can boost biodiversity and strengthen residents' connection to nature.
- **Engage the Community in Conservation Efforts:** Involve local residents in conservation activities, such as invasive species eradication programs or citizen science projects like the City Nature Challenge, to enhance biodiversity and foster community engagement.
- **Integrate Sustainable Land Use Planning:** Incorporate strategies that protect and restore natural habitats, such as the Vision and Strategy for the Waikato River, to ensure that development practices are environmentally sustainable and culturally sensitive.
- **Adopt Sustainable Design Frameworks:** Use frameworks like Green Star, BREEAM, and LEED, which include criteria for biodiversity and ecological conservation, to guide urban development and meet sustainability goals.

2.1.7 Resilient & Future Focussed

As urban areas face increasing challenges from climate change and environmental degradation, the trend towards resilient and future-focused sustainable urban design is becoming more critical. Incorporating resilience into urban planning not only helps communities adapt to and recover from extreme weather events but also improves the overall sustainability of buildings and infrastructure. According to the United Nations Office for Disaster Risk Reduction, nearly 84 % of the fastest growing cities face extreme climate and disaster risks (Okai, 2022). By focusing on resilience, urban design can effectively address both current and future environmental challenges, ensuring long-term viability and reduced impact on natural resources.

Leadership and Strategy: The effectiveness of the city's governance and strategic planning in fostering resilience. Resilient and future-focused communities are designed to be self-sufficient and adaptable, addressing complex challenges such as climate change and transitioning to a low-carbon economy. Key aspects of such communities include:

- **Reduced Reliance on the Grid**: Incorporating onsite renewable energy generation, such as solar panels and wind turbines, to minimise dependency on external power sources.
- **Waste Reduction and Resource Transformation**: Implementing systems for reducing waste, recycling, and turning waste into valuable resources, such as composting and waste-to-energy technologies.
- **Water Conservation**: Using water-saving technologies and practices to ensure sustainable water use, such as rainwater harvesting and efficient irrigation systems.

- **Local Food Production**: Encouraging urban agriculture and community gardens to reduce food miles and increase food security.

Emerging trends in New Zealand and globally related to resilient cities include:

- **New Zealand Coastal Policy Statement**: This policy outlines how to manage coastal areas to address climate change impacts such as erosion and sea-level rise. It emphasizes the need for integrated coastal management and resilience planning.
- **Auckland's Resilience Strategy**: Auckland's strategy focuses on building resilience through sustainable infrastructure, community engagement, and emergency preparedness. It includes measures like developing green infrastructure and enhancing community networks.
- **Masdar City, UAE**: This sustainable urban development is designed to be self-sufficient with renewable energy, waste recycling, and water conservation systems. It serves as a model for creating future-focused, low-carbon communities.
- **Copenhagen's Climate Plan**: Copenhagen aims to become the world's first carbon-neutral capital by 2025. The plan includes flood protection measures, energy-efficient buildings, and extensive green infrastructure.

The drive towards net-zero carbon emissions is pushing for greater integration of decentralised energy solutions. For example, rooftop solar panels are becoming increasingly popular in residential and commercial buildings, reducing reliance on grid power and increasing energy resilience. Battery storage systems further support this trend by enabling energy users to store excess solar energy, which can be used during peak times or outages, reducing stress on the grid. There is currently around 270 MW of installed solar generation in New Zealand. There is about 200 MW of rooftop solar on residential buildings across New Zealand. In 2022, New Zealand had a record amount of distributed solar generation installed (68 MW) (Electricity Authority, NZ, 2023) (refer to Figure 7).

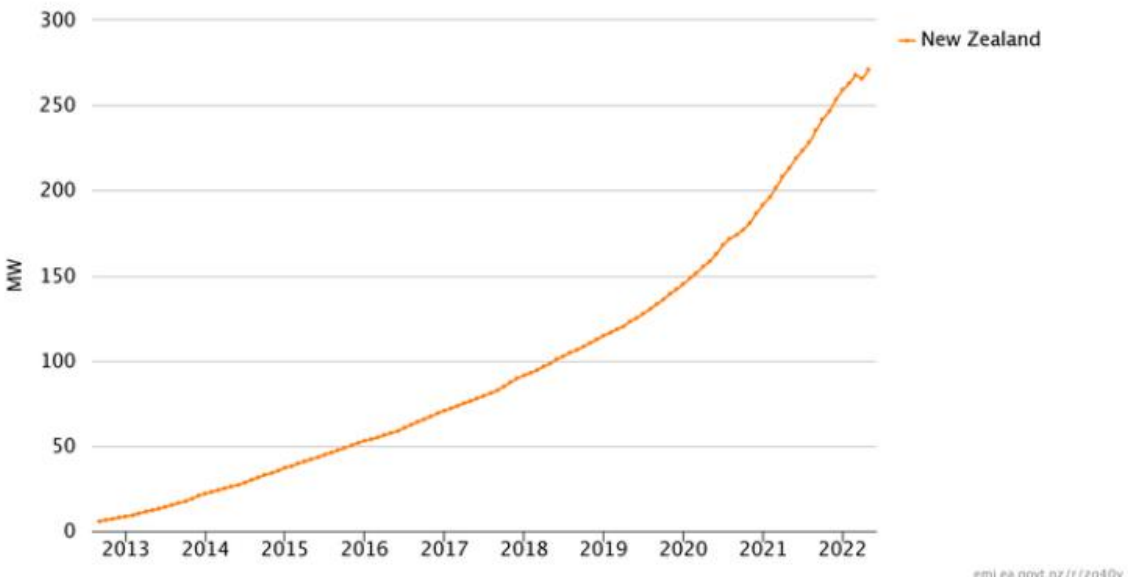


Figure 7 Increase in rooftop solar in New Zealand - 2013 to 2022 (Electricity Authority, NZ, 2023)

The increased uptake of electric vehicles (EVs) and other renewable technologies is also driving down costs due to economies of scale in production and manufacturing. As more consumers adopt EVs and solar technology, the cost of these systems is expected to decrease further, making them more accessible. In New Zealand, initiatives such as the Clean Car Discount and government support for renewable energy projects are promoting the adoption of EVs, rooftop solar, and battery storage. Consumers are also showing an increased willingness to pay (WTP) for these technologies as they become mainstream, especially as awareness grows about long-term savings and the environmental benefits associated with sustainable energy solutions.

Additionally, innovations in smart grid technology, demand-response systems, and energy-efficient building design are being integrated into developments. The integration of smart meters, energy management systems, and EV charging infrastructure in buildings allows for real-time monitoring and optimisation of energy use, ensuring efficiency and reducing waste. Given New Zealand's strong commitment to sustainability, as outlined in its Zero Carbon Act and renewable energy targets, the trend towards adopting these technological innovations will continue to gain momentum, contributing to Auckland’s transformation into a low-carbon, energy-efficient urban hub.

These key attributes generally form the pillars of a sustainable community development, each underpinned by key strategies, objectives and initiatives. Alignment of Sunfield design principles and initiatives against these global trends is summarised within Section 4 and further detailed within Appendix A.1.

2.2 Global GHG Targets

Climate change, driven by human activity, poses a critical threat to global communities, infrastructure, the environment, and the economy. Recognizing the urgency of this issue, the Intergovernmental Panel on Climate Change (IPCC) was established in 1988. The IPCC provides policymakers with scientific assessments on climate change, its impacts, and strategies for adaptation and mitigation.

The Paris Agreement, adopted in December 2015 under the United Nations Framework Convention on Climate Change (UNFCCC), represents a major international effort to combat climate change. The agreement aims to limit global temperature rise to well below 2°C above pre-industrial levels, with a goal of pursuing efforts to restrict the increase to 1.5°C. To meet these targets, participating countries submit Nationally Determined Contributions (NDCs) outlining their climate strategies and emission reduction goals. The IPCC has recently emphasized that exceeding the 1.5°C threshold will lead to severe and irreversible consequences.

Example global GHG emission targets include:

- **United States:** Reduce GHG emissions by 50-52% below 2005 levels by 2030 and achieve net-zero emissions by 2050.
- **India**: Reduce the carbon intensity of its GDP by 33-35% below 2005 levels by 2030 and achieve 50% of electricity generation from non-fossil sources.
- **Japan**: Reduce GHG emissions by 46% by 2030 compared to 2013 levels and achieve carbon neutrality by 2050

Examples of New Zealand’s national and local council targets:

- **New Zealand**: Reduce GHG emissions to 50% below 2005 levels by 2030. Achieve net-zero GHG emissions by 2050, with a 10% reduction target for methane emissions by 2030.
- **Auckland Council**: Achieve net-zero emissions by 2050 as part of the Auckland Climate Plan. The plan includes reducing emissions by 50% by 2030 compared to 2016 levels.
- **Wellington City Council**: Achieve net-zero emissions by 2050, with an interim target to reduce emissions by 30% below 2016 levels by 2030.

3 GHG Emissions Policy Landscape

3.1 Policy Overview

Several statutory documents, strategies, and plans have been established across various governance levels in New Zealand that provide guidance on how the proposed development should be assessed and implemented with respect to carbon emissions. The key policy landscape relevant to Sunfield and considered throughout this assessment is summarised in Table 2.

Table 2 Policies, regulations and strategies relating to GHG emissions and climate change mitigation

Policy	Description	Applicability
The Resource Management Amendment Act 2020 (RMA)	The Resource Management Amendment Act 2020 updated New Zealand's Resource Management Act (1991) to streamline processes, boost public engagement, improve freshwater management, and strengthen climate change responses. This revision allows individuals to propose modifications to district or regional plans and requires councils to integrate emission reduction and adaptation strategies from the Climate Change Response Act 2002 into their policies and planning. It also gives councils the authority to address GHG emissions in their regional planning and resource consent activities.	New Zealand
The Climate Change Response Act 2002 (CCR)	The Climate Change Response Act 2002 provides New Zealand's legal framework for addressing climate change. It aims to limit global warming to 1.5°C above pre-industrial levels and to adapt to climate impacts, in line with commitments under the UNFCCC and the Kyoto Protocol. Amended in 2019 by the Climate Change Response (Zero Carbon) Amendment, the Act aligns with the Paris Agreement's temperature goals and includes requirements for an emission reduction plan, a national adaptation plan, specific GHG reduction targets, and a system of emission budgets.	New Zealand
Aotearoa New Zealand Emissions Reduction Plan (ERP)	The Emissions Reduction Plan (ERP) outlines strategies, policies, and actions to meet New Zealand's first emissions budget as required by the Climate Change Response Act 2002. Released in 2022, the plan mandates government action to cut emissions across the economy and assist New Zealanders in benefiting from this transition, aiming to reduce	New Zealand

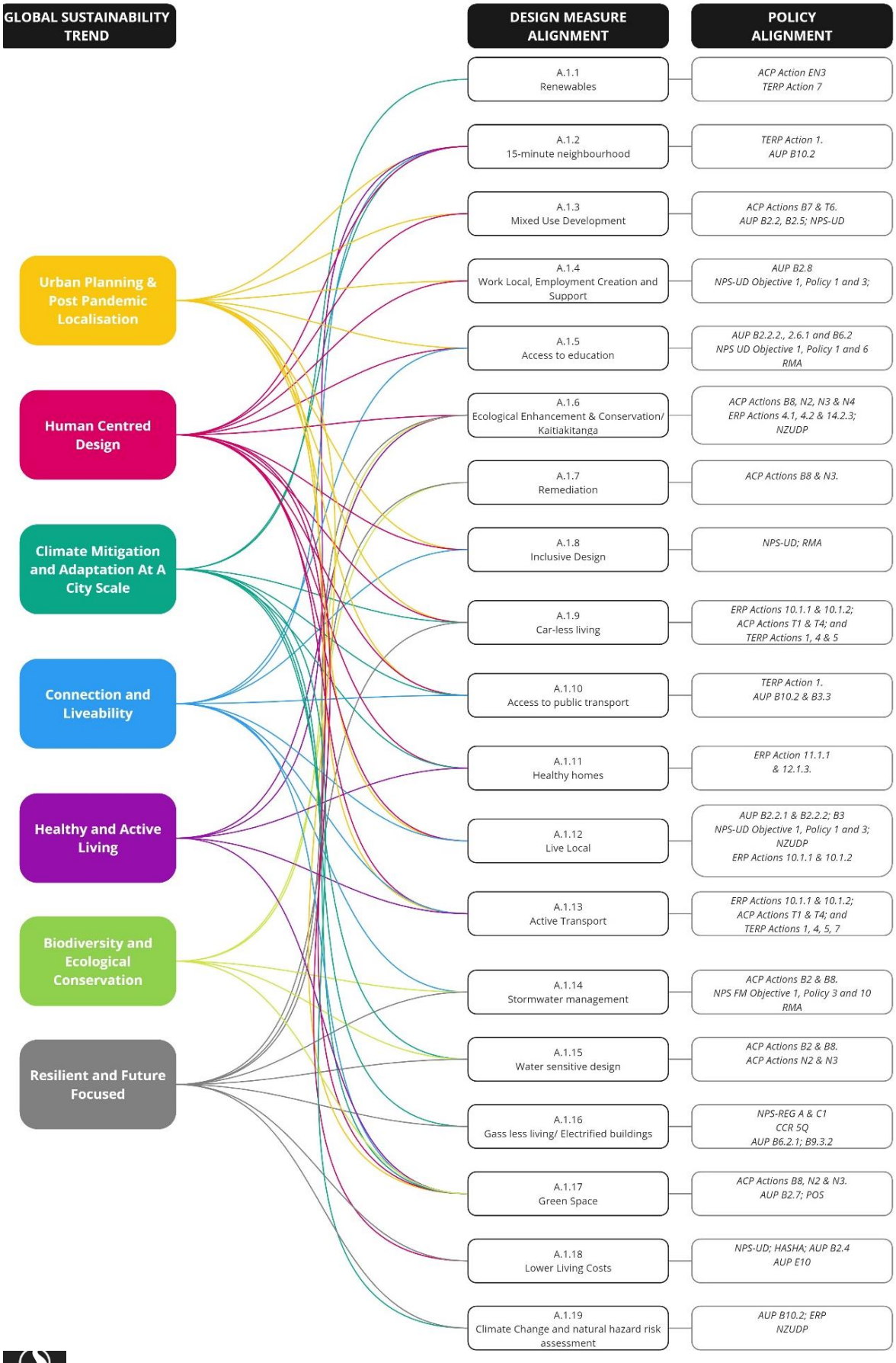
	living costs and enhance living standards. The next ERP is scheduled for publication by December 31, 2024.	
National Policy Statement on Urban Development, 2020 (NPS-UD)	The National Policy Statement on Urban Development (NPS-UD) offers a framework for managing urban growth with an emphasis on sustainable development and coordination among local authorities and developers. In response to rapid urbanization, the NPS-UD addresses housing and business requirements, aligns with the Urban Growth Agenda, and respects the principles of the Treaty of Waitangi.	New Zealand
National Policy Statement for Freshwater Management 2020 (NPS)	The NPS for freshwater management provides national policy settings that relevant statutory agencies including local authorities must comply with. Central to the NPS is the concept of Te Mana ō Te Wai set out in s1.3. This is an aspirational concept that means that the integrity (physical and spiritual) of all water is upheld to its highest possible quality or state.	New Zealand
Iwi Management Plan, 1995 (IMP)	Te Kawerau ā Maki Resource Management Statement (1995) was lodged with Council explicitly as an iwi authority planning document under sections 66(c) and 74(b) of the RMA 1991 (since repealed). The IMP describes the continuing role of Te Kawerau ā Maki as kaitiaki (guardians) and provides policies to guide statutory authorities and applicants. Policy 2.2(2) promotes the integration of Te Kawerau ā Maki tikanga in resource management, while clause (3) requires engagement by all agencies within the rohe to help give effect to the kaitiaki role of the iwi	New Zealand
Te hau mārohi ki anamata - Aotearoa New Zealand's first Emissions Reduction Plan, 2022 (ERP)	"Te hau mārohi ki anamata" is Aotearoa New Zealand's first Emissions Reduction Plan, released by the Ministry for the Environment in 2022. The plan outlines the country's strategy for reducing GHG emissions across various sectors to meet its climate goals. It focuses on transitioning to a low-emission economy, promoting sustainable practices, and ensuring that the transition is equitable and inclusive. The plan includes actions for reducing emissions in energy, transport, agriculture, and waste, and emphasizes the importance of collaboration between government, businesses, and communities.	New Zealand
New Zealand Emission Trading Scheme (NZ ETS)	New Zealand's Emissions Trading Scheme (NZ ETS) is a market-based system designed to help the country meet its international and domestic climate change obligations by limiting GHG emissions. The NZ ETS supports Aotearoa New Zealand to meet its emissions reduction goals by putting a price on GHG emissions. The NZ ETS covers key sectors like energy, transport, forestry, and waste, and it aims to drive investment in low-carbon technologies while helping New Zealand achieve its emissions reduction targets.	New Zealand
Auckland Climate Plan 2020 (ACP)	The Auckland Climate Plan 2020 is a comprehensive strategy aimed at addressing climate change in the Auckland region. The plan sets out to reduce GHG emissions and enhance resilience to the impacts of climate change. Key targets include achieving a 50% reduction in emissions by 2030 and reaching net-zero emissions by 2050. The plan covers various sectors, including energy, transportation, buildings, and waste management.	Auckland, New Zealand

Auckland Transport Emissions Reductions Plan 2022 (TERP)	The Auckland Transport Emissions Reductions Plan 2022 outlines strategies to significantly reduce emissions from the transportation sector. The plan focuses on increasing the use of public transport, cycling, and walking, and promoting the adoption of electric vehicles (EVs). It aims to align with the broader goals of the Auckland Climate Plan to help the city achieve its emission reduction targets.	Auckland, New Zealand
Auckland Future Development Strategy 2023-2053 (AFDS)	The Auckland Future Development Strategy 2023-2053 outlines the long-term vision for urban growth and development in Auckland. The strategy emphasizes sustainable growth, focusing on creating resilient, inclusive, and liveable communities. It aims to balance the need for housing and economic development with the preservation of natural resources and the environment.	Auckland, New Zealand
Auckland Unitary Plan 2011 (AUP)	At a Local Government level, the Auckland Unitary Plan (AUP) provides for the protection and management of matters of importance to Mana Whenua including the environment and cultural heritage. These matters are set out in the Regional Policy Statement Chapter B6, but are also embedded in the lower-order policies and rules throughout the Plan.	Auckland, New Zealand

4 Alignment with Global Sustainability Trends and National Policy

Based on assessment of Sunfield's proposed design against the global sustainability trends explored in Section 2 and GHG emissions policy explored in Section 3, there is strong alignment and contribution towards global sustainable trends and GHG policy targets. The integrated approach to embedding human-centred, nature-based solutions within the design aligns with each of the global trends identified, including the priority actions of climate change mitigation, adaptation and resilience.

Sunfield's mapped alignment is summarised in the infographic (overpage) illustrating Sunfield's design measures (centre) against the global trends and policy, with further detail provided within Appendix A.1.


GLOBAL SUSTAINABILITY TREND
DESIGN MEASURE ALIGNMENT
POLICY ALIGNMENT
Urban Planning & Post Pandemic Localisation
Human Centred Design
Climate Mitigation and Adaptation At A City Scale
Connection and Liveability
Healthy and Active Living
Biodiversity and Ecological Conservation
Resilient and Future Focused
A.1.1 Renewables
ACP Action EN3
TERP Action 7
A.1.2 15-minute neighbourhood
TERP Action 1.
AUP B10.2
A.1.3 Mixed Use Development
ACP Actions B7 & T6.
AUP B2.2, B2.5; NPS-UD
A.1.4 Work Local, Employment Creation and Support
AUP B2.8
NPS-UD Objective 1, Policy 1 and 3;
A.1.5 Access to education
AUP B2.2.2., 2.6.1 and B6.2
NPS UD Objective 1, Policy 1 and 6
RMA
A.1.6 Ecological Enhancement & Conservation/ Kaitiakitanga
ACP Actions B8, N2, N3 & N4
ERP Actions 4.1, 4.2 & 14.2.3;
NZUDP
A.1.7 Remediation
ACP Actions B8 & N3.
A.1.8 Inclusive Design
NPS-UD; RMA
A.1.9 Car-less living
ERP Actions 10.1.1 & 10.1.2;
ACP Actions T1 & T4; and
TERP Actions 1, 4 & 5
A.1.10 Access to public transport
TERP Action 1.
AUP B10.2 & B3.3
A.1.11 Healthy homes
ERP Action 11.1.1
& 12.1.3.
A.1.12 Live Local
AUP B2.2.1 & B2.2.2; B3
NPS-UD Objective 1, Policy 1 and 3;
NZUDP
ERP Actions 10.1.1 & 10.1.2
A.1.13 Active Transport
ERP Actions 10.1.1 & 10.1.2;
ACP Actions T1 & T4; and
TERP Actions 1, 4, 5, 7
A.1.14 Stormwater management
ACP Actions B2 & B8.
NPS FM Objective 1, Policy 3 and 10
RMA
A.1.15 Water sensitive design
ACP Actions B2 & B8.
ACP Actions N2 & N3
A.1.16 Gass less living/ Electrified buildings
NPS-REG A & C1
CCR 5Q
AUP B6.2.1; B9.3.2
A.1.17 Green Space
ACP Actions B8, N2 & N3.
AUP B2.7; POS
A.1.18 Lower Living Costs
NPS-UD; HASHA; AUP B2.4
AUP E10
A.1.19 Climate Change and natural hazard risk assessment
AUP B10.2; ERP
NZUDP

5 Greenhouse Gas Emissions Assessment

Stantec have prepared a GHG emissions assessment for the proposed Sunfield development, based on conceptual design information that was available at the time of undertaking. The purpose of this assessment is to identify the significant emission sources and determine the approximate carbon footprint range, in order to assist in future strategic decision-making and emissions reductions.

5.1 Methodology

5.1.1 Industry Standards

The GHG assessment approach has been adapted from the following industry standards and guidelines:

- British Standard Institute, PAS 2080:2023 Carbon management in buildings and infrastructure.
- British Standard Institute, EN17472:2022 Sustainability of construction works. Sustainability assessment of civil engineering works. Calculation methods.
- The Ministry for the Environment, Measuring emissions: A guide for organisations: 2023 detailed guide.
- Ministry of Business, Innovation & Employment, Whole of Life Embodied Carbon Assessment: Technical Methodology.

In alignment with the PAS 2080 framework, capital and operational carbon is the adopted terminology used to categorise emission sources and reductions throughout this assessment. Capital carbon refers to the GHG emissions and removals associated with the creation of the asset, this typically aligns with the scope of capital expenditure for the development. Whereas operational carbon refers to the GHG emissions and removals which enable the asset to operate and deliver its intended services.

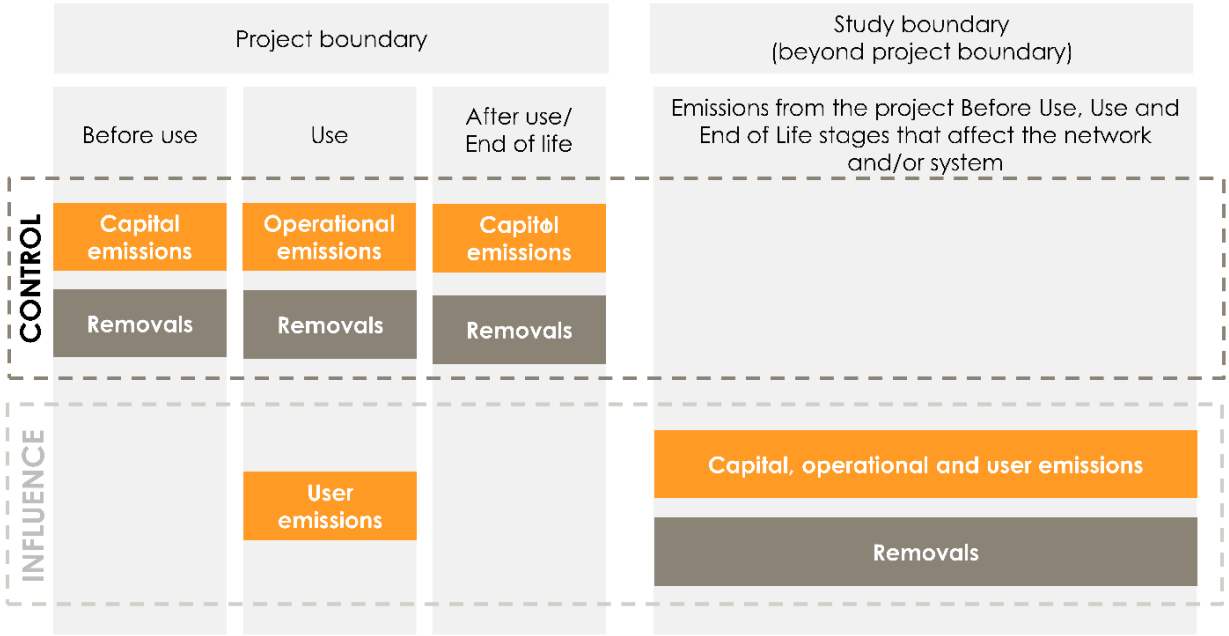


Figure 8 Whole life carbon framework for decision-making, adapted from PAS 2080

The accuracy of the GHG assessment is contingent upon the availability and reliability of data. At this stage detailed design information is not available, requiring substantial assumptions to undertake the assessment. Consequently, the emissions estimates provided in this report are of low accuracy. This level of accuracy is appropriate and expected at this stage of the project. The emission sources identified, and comparative magnitude remains relevant to the assessment purpose and can be built on once more detail design information is available.

5.1.2 Tools and Resources

Various tools and resources were utilised in order to estimate Sunfield's capital and operational GHG emissions footprint which are outlined below in Table 3.

Table 3 Applicable Tools and Resources

GHG Emissions Type	Development Application	Tool/ Resource	Required Data	Notes
Capital	Buildings (Residential & Commercial)	Infrastructure Australia, Appendix E – Emission intensities	GFA	No Auckland specific data was available at the time of this assessment providing the relevant emission intensities required.
Capital	Roads	Project Emissions Estimation Tool (PEET) Excel Tool Version 4.0 (v4)	Lane-km	This is a New Zealand specific tool and provides a high-level estimate of capital road GHG emissions.

Operational	Buildings (Commercial)	NABERS New Zealand	GFA, Building Type, Energy profile	This is a New Zealand specific tool.
Operational	Buildings (Residential)	Home Star, Branz & Census Data	Numb. Of dwellings, GFA	These tools and resources are specific to New Zealand.
Operational	Roads	PEET v4	Lane-km	This is a New Zealand specific tool and provides a high-level estimate of operational road GHG emissions.
Operational	Emission Factors	"Measuring emissions: A guide for organisations", New Zealand Government	kgCO2e/unit	This is New Zealand specific emission factors used for operational GHG emissions assessment.

5.1.3 Emissions Scenarios

As the assessment contains a high degree of uncertainty at this phase, multiple scenarios are modelled where practicable to establish the approximate range of the emission footprint. For capital emissions, three scenarios are presented based on the emission factors defined in Infrastructure Australia's 'Embodied Carbon Projections for Australian Infrastructure and Buildings" (2024). These scenarios were determined by examining the capital carbon of asset types throughout the country to establish emissions factors relative to GFA, for a high-, medium- and low-emission range.

These scenarios help address the larger degree of uncertainty associated with GHG assessment, and in particular emission intensities factors, discussed in more detail in Section 5.5.4. Various studies have discussed that embodied carbon data can have an uncertainty range from 29% up to 155% (Marsh et al., 2021). And the use of differing embodied carbon databases can affect the results by an additional 6% variation (Mohebbi et al., 2021).

5.2 Assessment Boundary

The assessment boundaries for the Sunfield GHG emissions assessment encompasses defined physical (geographic), process and temporal boundaries as further described below.

Physical Boundary

The assessment boundary for Sunfield encompasses both capital and operational emissions. The geographic limits defined by the development areas, as illustrated in Figure 9 below, have been adopted as the limits for this study.

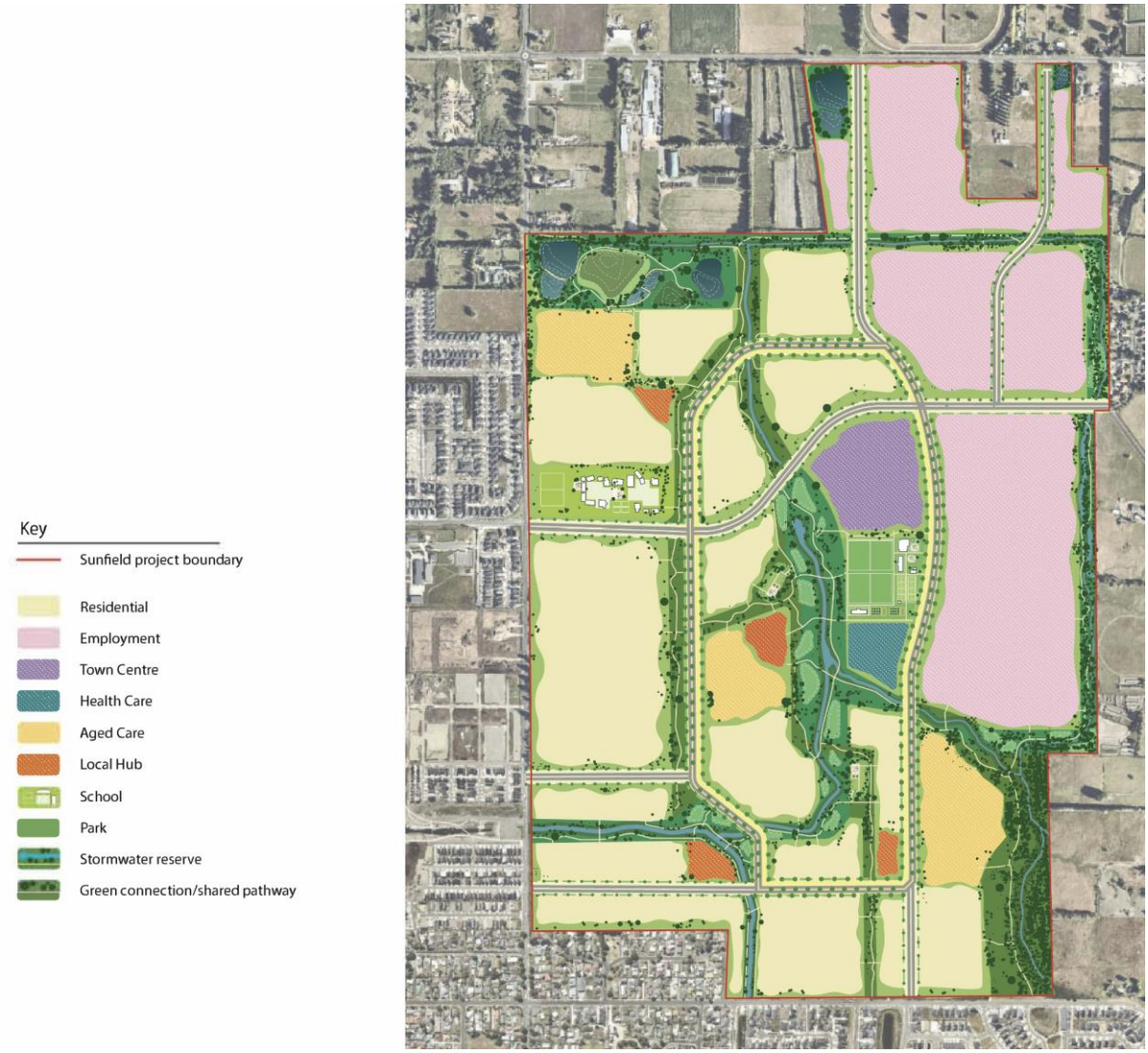


Figure 9 Sunfield Masterplan – Physical boundary

Process Boundary

Whole of life carbon emissions are categorised according to life cycle stages or modules, as outlined in the EN17472 standard. This assessment adopts these modules to define the assessment boundary and to analyse emission sources, as detailed in Figure 10 below.

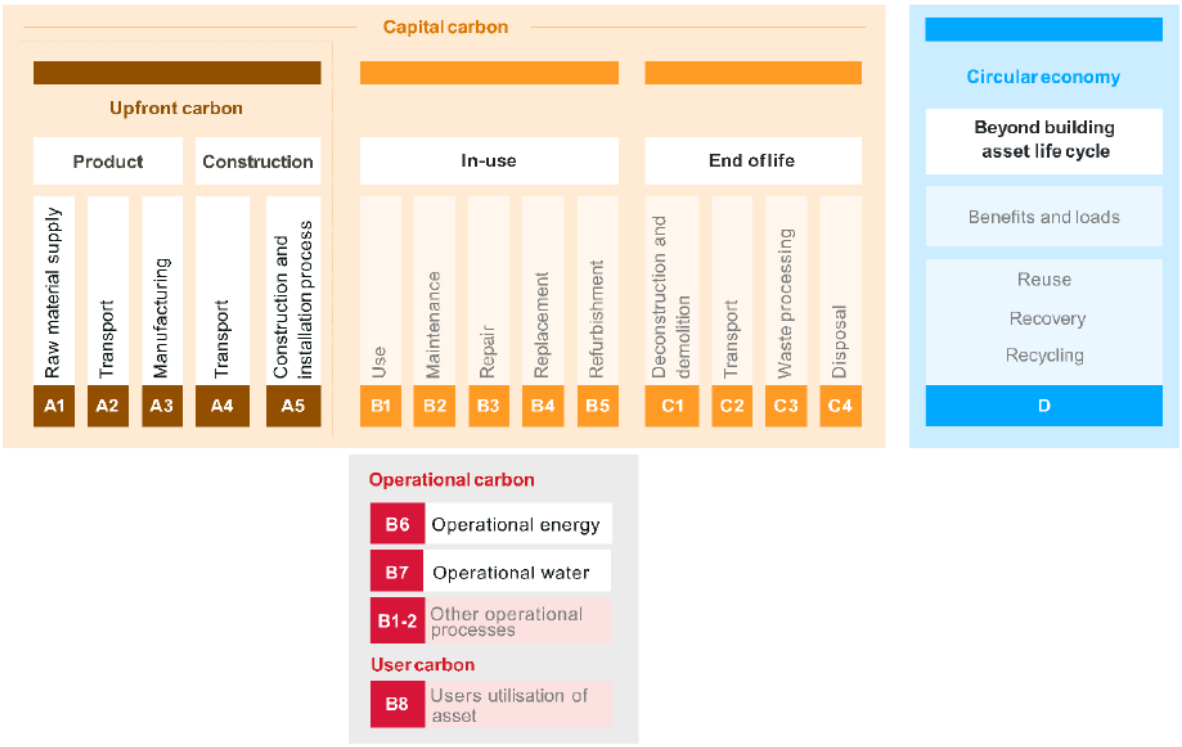


Figure 10 Sources of whole life carbon emission with quantified modules (A1-A5 and B6-B7) depicted in white, adapted from PAS2080:2023 and modules in EN 17472:2022

Capital emissions associated with the supply of raw materials and products (Modules A1-A3) as well as construction activities and transportation of materials to the site (Modules A4-A5) are within the scope of this assessment. Similarly, operational emissions associated with energy use (Modules B6) of the residential buildings has been estimated. All other modules depicted in Figure 10 are beyond the scope of this assessment.

Temporal Boundary

As the asset's design life is yet to be established, operational emissions are presented on an annual basis, indicative of the New Zealand energy profile captured in the Ministry for the Environment's 2023 Summary of Emission Factors.

5.3 Emissions Sources

The GHG assessment encompasses the capital and operational emission sources listed in Table 4, noting the developer generally has a high to moderate level of control regarding these emissions sources through design and construction strategies. Modelling assumptions related to the following emission sources are outlined within Appendix A.2.

Table 4 Emission Sources Assessed

Emission Category	Life Cycle Modules	Project Element	Emission Sources Assessed
Capital	Product (A1-A3)	Transport Infrastructure	• Pavements • Road Base • Aggregates
Capital	Product (A1-A3)	Buildings	• Structure • Foundations • Envelope – façade, cladding, glazing, roof, insulation • Core building services – HVAC, lighting, hydraulic systems • Core fit out elements – ceilings, wall coverings
Capital	Construction (A4-A5)	Buildings and Transport Infrastructure	• Electricity consumed • Fuel consumption of plant, equipment and site vehicles • Transport of materials to site • Waste generated onsite • Transport of waste to end destination
Operations	Operational Energy (B6)	Buildings	• HVAC heating and cooling • Fans • Internal lighting • Plug loads • Domestic hot water

All emission sources listed above are based on assumptions and aggregated data, as more detailed data is not available at this stage of the design. These emission sources are further aggregated into core categories (which includes the emissions sources assessed in Table 5), as detailed in Table 5 below.

Table 5 Emission Source Category

Emission Source Category	Emission Source Subcategory	Category Type
Buildings	Residential	Detached
		Terrace
		Retirement Housing
	Education	School
		Early Childhood
	Healthcare	Medical Centre
	Commercial	Retail
		Office
		Warehouse
		Communal parking
Transport Infrastructure	Roads	Sunfield Loop – shared movement corridor

5.4 Future Considerations

Emissions sources identified for consideration in future analysis (which are not able to be quantified due to the preliminary nature of project information available at this phase) are outlined below in Table 6. It is important to note that this list is not exhaustive, and a detailed assessment is recommended at future project stages.

Table 6 Emission Sources for Future Considerations

Emission Category	Life Cycle Modules	Project Element	Emission Sources for Future Considerations
Capital	Product (A1-A3) Construction (A4-A5)	Buildings, Infrastructure, Transport	Construction methodology and material selection
			Material suppliers and haulage distance
			Internal and external finishes
			Material specifications and EPDs
Operations	Use (B1-B7)	Site, Buildings	Waste generation & management Pavement maintenance
			Passive & high-performance building design strategies
			Renewables specific to each building type
			Detailed mechanical services
			Outdoor lighting, equipment, plug load, etc.
			Communal activities: Gym/ Pools/ etc.

5.5 Greenhouse Gas Assessment Results

5.5.1 Capital Emissions

Buildings

Capital emission estimates across a range of scenarios for the residential buildings are presented in Figure 11 for product, (A1-A3), transport (A4) and construction (A5) emissions. All scenarios are presented to capture the potential range of embodied emissions at this phase, and the relative magnitude of each life cycle module. The product stage (A1 to A3) represents the highest proportion of capital emissions and therefore present a significant opportunity to focus decarbonisation strategies on in future design phases.

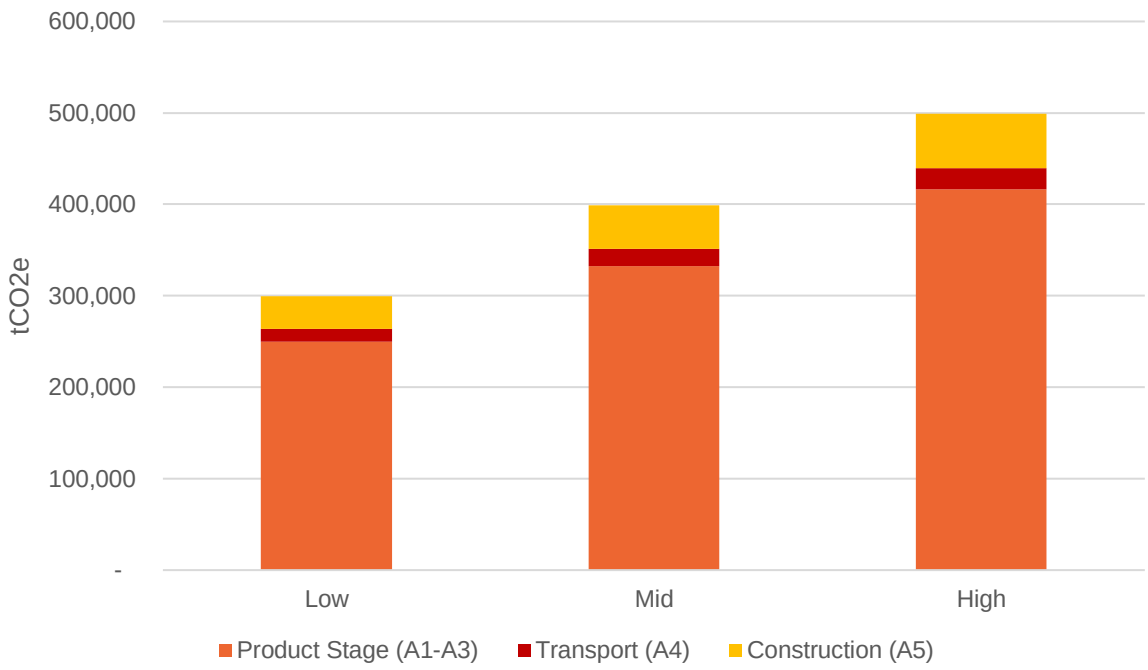


Figure 11 Breakdown of Sunfield's building capital emissions per system boundary stage for low, mid and high scenario

Table 7 provides a detailed breakdown of the estimated capital emissions range for all buildings for system boundary A1 to A5. The total capital emissions scenarios range from 299,721 to 499,211 tCO_2e, translating to a range of 327 to 545 $kgCO_2e/m^2$.

Table 7 Capital emissions for buildings - Low to High Scenario (tCO_2e)

	Type	Low	Mid	High
All buildings A1 to A5	Residential Units	107,174	142,579	178,445
	Retirement	22,893	30,490	38,173
	Medical Centre	8,729	11,642	14,558
	Office	22,923	30,555	38,205
	Warehouse	81,846	94,838	136,287
	Early Childhood	1,419	1,657	2,367
	Communal Parking	8,704	11,592	14,500
	Retail	58,752	78,246	97,875
	Total (tCO_2e)	299,721	384,645	499,211

Figure 12 below provides a percentage breakdown of the various building capital emissions (for the medium scenario). It can be noted that residential, warehouse and retail make up the largest proportion of Sunfield's capital emissions for buildings.

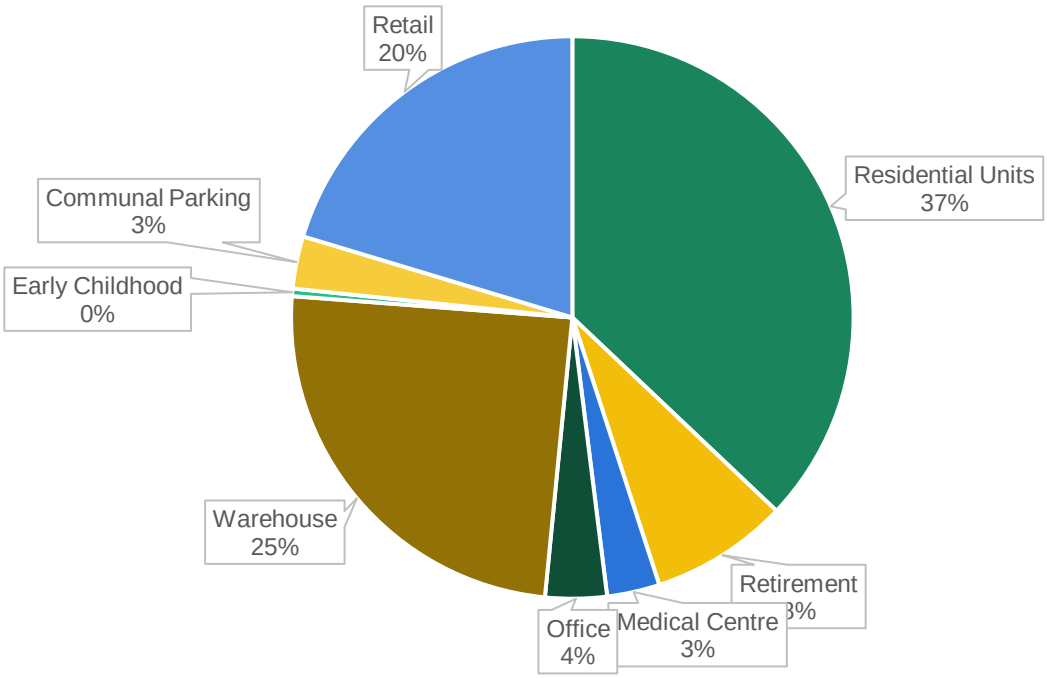


Figure 12 Percentage breakdown of capital emissions for Sunfield Buildings - A1 to A5, mid scenario

Transport Infrastructure

For the quantification of the transport infrastructure capital GHG emissions (the Sunfield loop), PEET v4.0 was utilised. The estimated capital emissions for the new transport infrastructure (based on an assumed road length of 7.58km with 4 lanes), is estimated to be approximately 69,736 tCO_2e for the A1 to A5 (Product and Construction) system boundary.

Total Capital Emissions

Understanding the relative magnitude of emissions in a project enables decarbonisation efforts and decision-making to focus on high-impact areas. Assuming a mid-range emission scenario, capital emissions for Sunfield by project element is illustrated in Figure 13 below. Residential buildings and non-residential buildings (including employment, town centre, health care and the local school) comprise the most significant proportion of capital emissions (A1 to A5) representing 38% and 47% of the footprint respectively. Transport infrastructure represents 15% of the footprint.

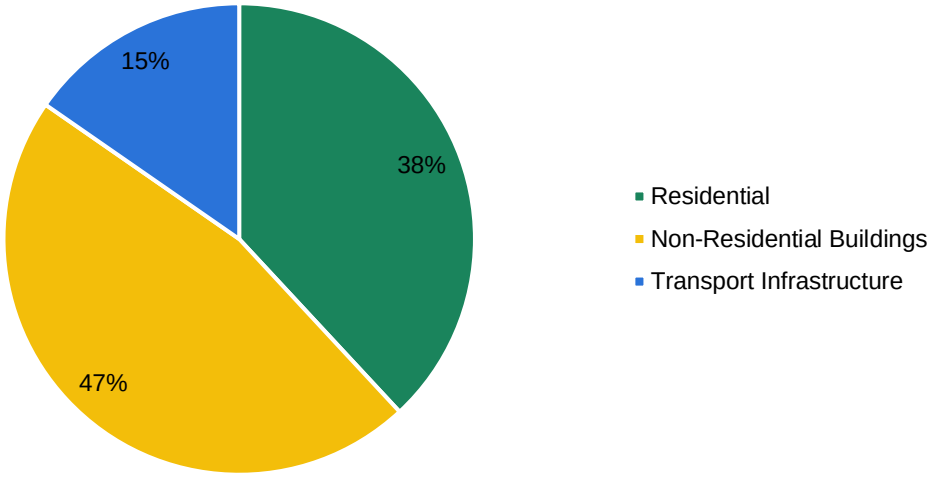


Figure 13 Total capital emissions breakdown of Sunfield (tCO2-e)

Embodied carbon associated with products and materials (A1-A3) significantly contribute to emissions, regardless of scenario intensity. As such, considering decarbonisation strategies to reduce the material intensity across the development lifecycle in future design phases is encouraged. Avoiding using materials through design decisions, maximising the use of existing materials, and maximising the use of low carbon materials including those with recycled content are effective ways to minimise embodied carbon, listed in order of priority.

Similarly, significant emissions are generated from construction activities (A4-A5) due to fuel consumption, machinery, and transport. Strategies to address these emissions include transitioning to biodiesel for construction equipment, adopting electric or hybrid machinery where feasible, optimising fuel use through efficient machinery operation, reducing idling time, and maximising the use of renewable energy sources on-site. These measures, along with effective logistics planning to minimise transport emissions, are effective strategies to reduce the overall capital carbon footprint.

5.5.2 Operational Emissions

5.5.2.1 Buildings

This section provides an overview of Sunfield's Operational GHG emissions estimates (B6-B7). Operational emissions are presented on an annual basis, reflective of New Zealand's energy grid in 2023. Two scenarios have been used for these results, namely low (which represents an increase in adoption of low carbon materials and technologies) and high (which represents a slow uptake of low carbon materials and technologies).

The commercial building sector of Sunfield (which includes the retail, office, warehouse etc.) has an expected range of between 1,200 to 4,800 tCO_2e/year in operational GHG emissions. For residential, the range is between 2,20 and 3,300 tCO_2e/year. The total expected operational emissions have a range of 3,700 to 8,600 tCO_2e/year, as shown in Figure 14.

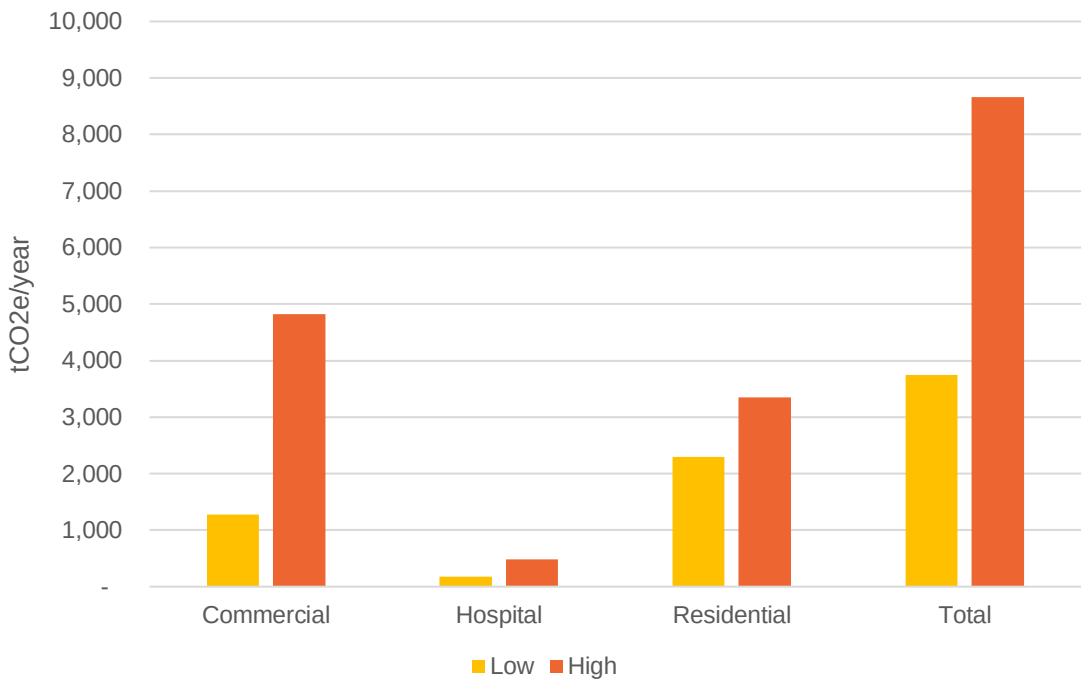


Figure 14 Operational GHG emissions for Sunfield's buildings

These values are expected to become possibly lower as more data and information regarding the renewables and thermal efficiency design of the building's envelopes become available in later design stages. Buildings energy use is largely driven by the building services, lighting and plug loads. Reducing the heating and cooling load, for instance through passive design strategies and high-performance enclosure design will minimise operational carbon emissions. As will the uptake of energy-efficient HVAC system design and equipment.

5.5.2.2 Renewables

The Sunfield development will include a renewable energy network, where all 3,800 homes (residential and retirement) are proposed to be equipped with 6.2-6.9 kW PV systems. The commercial, retail and employment areas will also have an extensive solar system installed with an aim of supplying 100% of the developments' required energy needs.

The impact on the developments' overall GHG emissions is uncertain at this early design stage due to lack of detail and data. However, based on the assumption of an estimated 'cradle-to-grave' emissions of solar power in the NZ to be 33g CO_2/kWh. The estimated CO_2 savings from a standard household solar PV system, considering construction emissions, would be 462Kg of CO_2 per year (Queenstown Solar, 2021). If this value were to be applied to all 4,000 homes for Sunfield, a reduction of over 1,800 tCO2e would be expected for the residential component. Thus, decreasing the residential's operational emissions from over 2,900 tCO_2e to just over 1,000 tCO_2e.

5.5.2.3 Transport Infrastructure

Transport is one of New Zealand's largest sources of emissions and accounts for 21% of New Zealand's annual GHG emissions (Transport New Zealand, 2024). Sunfield is revolutionising typical

residential living and associated transport infrastructure requirements, with its' fundamental principle of car-less living. Key Sunfield initiatives that would contribute to a reduced transport GHG emissions footprint are highlighted below:

- Promoting a modal shift away from reliance on private motor vehicles, encouraging use of shared cars, and active and public transport (including bike parking and a dedicated bike storage facility at Papakura Station).
- Provision of 16 EV charging stations, including 5 within the local hubs, 3 with the retirement villages, 5 within the employment zone, 2 within the town centre zone and 1 within the health care zone, encouraging uptake of EV's.
- The Sunbus EV fleet, comprising approximately 30 autonomous buses completing a total of approximately 88 trips around the Sunfield loop per hour.

5.5.3 Total GHG Emissions

Figure 15 illustrates Sunfield's total estimated capital and operational GHG emissions. The total estimated GHG emissions range from 500,000 to 669,000 tCO_2e. It is evident from Figure 15, that the developments' estimated capital emissions account for the largest proportion of the developments' expected GHG emissions. For the medium scenario, the capital accounts for over 70% of the total GHG emissions. This value is expected to be even lower once more detail is incorporated into future GHG modelling with regards to the solar PV energy network and decarbonisation of the grid. The uncertainty of these values is explored further in the following section.

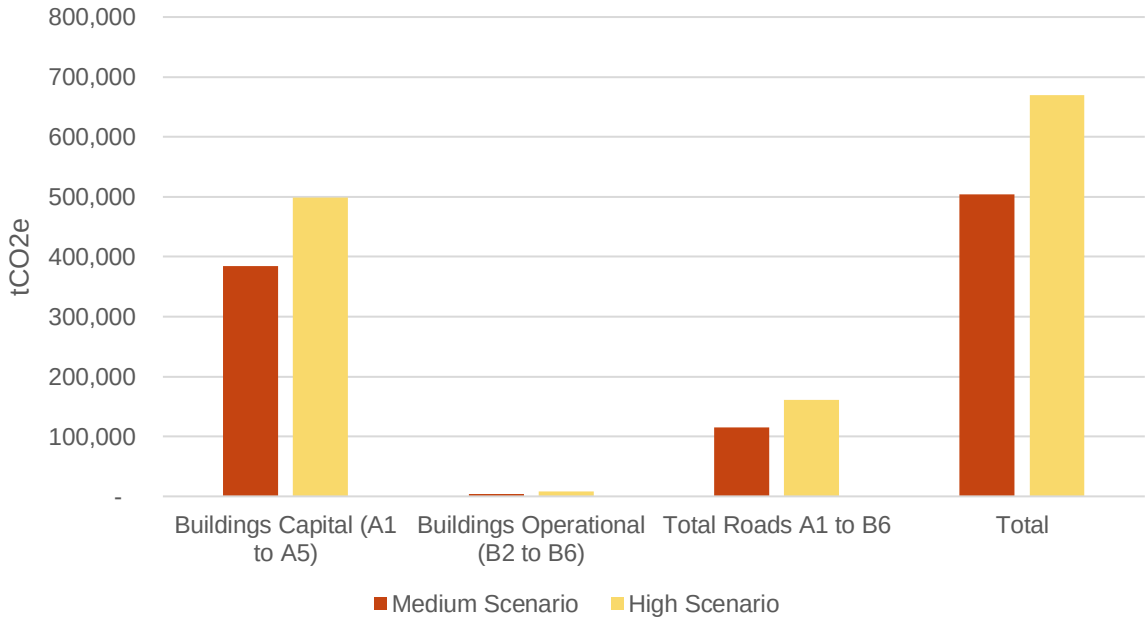


Figure 15 Total GHG Emissions for the Sunfield Development

5.5.4 Uncertainty Analysis

As previously outlined, various studies have discussed the uncertainty associated when it comes to GHG assessment results. A recent study (Stephan et al., 2022) stated the following uncertainty ranges should be used:

- Capital Emissions: ±40%
- Operational Emissions: ±20%
- Transport Emissions: ±20%

These ranges have been applied to the results discussed above and illustrated in the graph below. The results range as follows, as illustrated in Figure 16:

- Capital Buildings: 230,00 to 618,00 tCO_2e
- Operational Buildings: 3,600 to 8,100 tCO_2e
- Transport Infrastructure: 92,100 to 193,000 tCO_2e

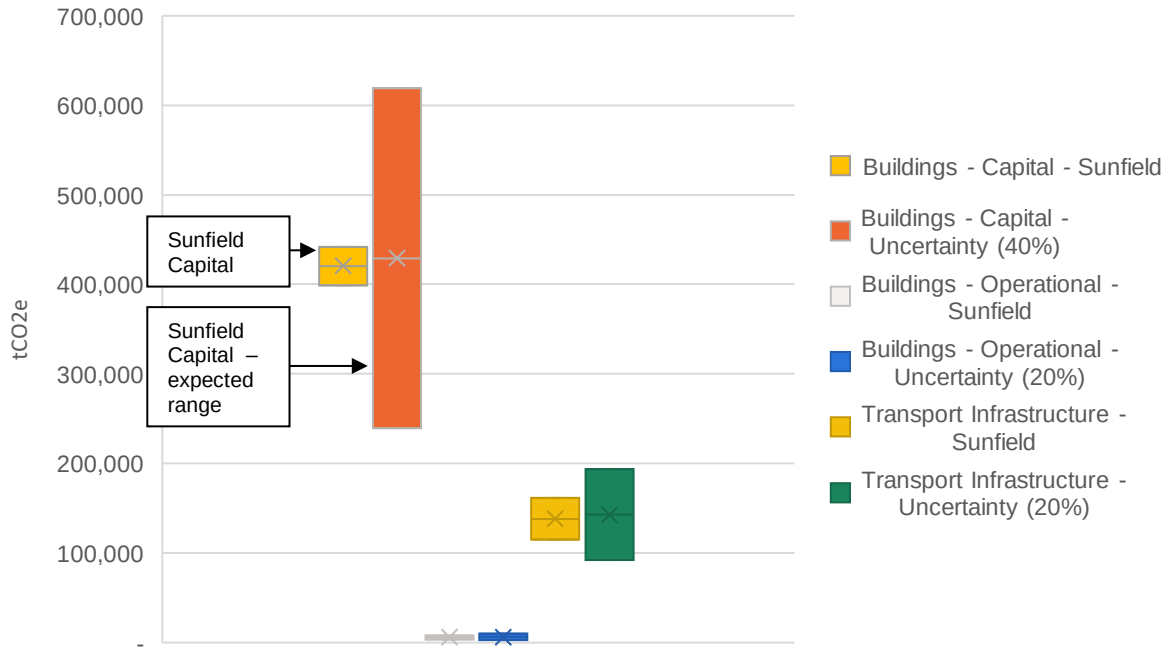


Figure 16 Uncertainty analysis of Sunfield's GHG emission

It is important to be aware that uncertainty ranges can differ depending on source. One such study reported uncertainty range from 29% up to 155% (Marsh et al., 2021). And the use of differing embodied carbon databases can affect the results by an additional 6% variation (Mohebbi et al., 2021). As more data and detail for the developments' design become available at later design stages, more detailed and accurate GHG estimations can be provided.

5.5.5 Summary of Results

In summary, the upfront capital emissions associated with the supply of raw materials and products (Modules A1-A3) during construction account for the largest proportion of Sunfield's total estimated lifecycle emissions footprint, particularly for the residential and commercial buildings which makes up the most significant proportion of the estimated GHG footprint. The proportional impact of the transport infrastructure is estimated to be approximately 15% of the overall footprint, representing the lowest contributor to capital emissions[3] as a result of the car-less design concept and significant reduction in transport infrastructure requirements. It is anticipated that the capital emissions associated with transport infrastructure will be reduced compared to a traditional community development.

Consideration of the Sunfield renewable solar PV network coupled with the decarbonisation of the grid will further increase the proportional significance of the capital emissions, specifically for buildings such as the warehouse, terrace and free-standing housing which make up the largest proportion of upfront emissions for buildings, based on the larger GFA footprint.

It is understood that WLL plan to design residential dwellings beyond building code compliance, aligning with Homestar guidance in order to improve HVAC and building performance, while maximising resident comfort. Prioritising passive design strategies and high-performance building design, in addition to the Sunfield renewable PV network will contribute to a reduced intensity of operational emissions, particularly for dwellings[4].

A comprehensive GHG emissions assessment is recommended to be undertaken at subsequent detailed design stages, once a more granular level of design detail is available and any genuine GHG emission reductions can be quantified.

6 Assessment of Effects

The construction and operational stages of the Sunfield development would involve activities that contribute to capital and operational GHG emissions. The potential effects (including positive and negative impacts), of the predicted capital and operational emissions has been evaluated and assessed utilising a bespoke risk-based approach. The risk-based assessment of effects facilitates the prioritisation of adverse impacts, enabling any significant adverse impacts to be treated in accordance with a mitigation hierarchy, in order to minimise or avoid the potential impact. In the absence of an NZ standard for assessing the effects of GHG emissions, a bespoke GHG assessment of effects methodology has been developed and adapted from best practice guidance including the following:

- Ministry for the Environment *A Guide to Preparing a Basic Assessment of Environmental Effects (AEE)*

[3] Based on the GHG emissions sources assessed where design information was available
[4] Homestar guidelines were not considered in undertaking this assessment

- New Zealand Association for Impact Assessment (NZAIA) *Environmental Impact Assessment*

A summary illustration of the adopted assessment of effects for GHG emissions is provided below in Figure 17.

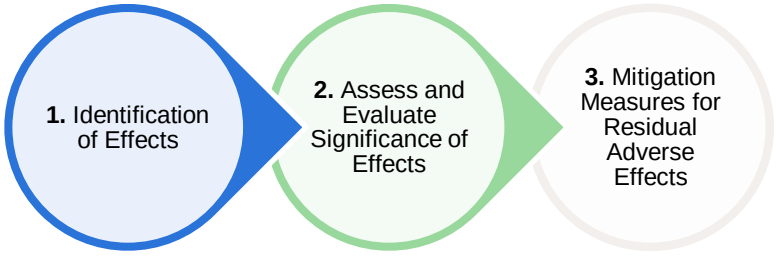


Figure 17 Assessment of effects

As outlined, following the identification of potential effects, the magnitude of each effect is assessed and evaluated in order to prioritise adverse residual impacts and inform appropriate mitigation measures.

6.1 Methodology

Effects have been identified based on each emission source and their associated potential impacts (positive and negative). Bespoke qualitative assessment criteria have been developed in order to assess and evaluate the magnitude of each potential effect (*Step 2* in Figure 17 above). The significance of each effect is a function of the assessed scope and influence, reversibility and duration of effect, as illustrated below in.

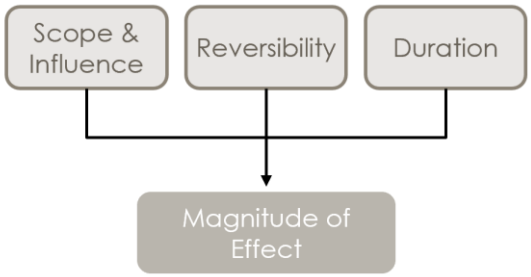


Figure 18 Effects assessment methodology

Table 8 below outlines the criteria for how the scope and influence, reversibility and duration of an effect have been defined, informing the resultant magnitude of effect through an assigned weighting. For the purposes of this assessment, effects initially assessed as having a *moderate* or *significant* adverse impact trigger the threshold for mitigation measure recommendations, in order to minimise or avoid the potential impact.

Table 8 Magnitude of effect criteria

Magnitude of Effect	Criteria		
	Scope & Influence	**Reversibility**	**Duration**
Insignificant effect (0-2)	Direct Emissions Influences on Site: Emission sources that can be directly influenced, controlled, and reduced on-site as part of the design, construction, and operation phases, where the developer has a high level of control (0)	Impact require no to minimal effort to reverse or offset the effects (0)	Temporary (less than one year) (0)
Minimal effect (3-4)	Indirect Emissions from Purchased Electricity: Indirect emissions resulting from purchased electricity, which cannot be directly controlled on-site; however, the developer has a level of influence through energy procurement strategies. (1)	Impact requires minimal effort to reverse or offset the effects (1)	Short-term or temporary (1-5 years) (1)
Moderate effect (5-7)	Indirect Emissions in the Value Chain: Indirect emissions within the value chain occurring upstream and downstream of the construction and operation, with limited direct influence. These emissions are influenced by choices in procurement and supplier engagement but remain largely outside the developer's direct control. (2)	Impact requires moderate effort to reverse or offset the effects (2)	Medium-term (5-10 years) (2)
Significant effect (8-9)	Indirect Emissions with Minimal Influence: Emissions for which the developer has minimal or no direct influence or control, largely dependent on third-party behaviours and practices (3)	Impact requires significant effort to reverse or offset the effects (3)	Long-term / Permanent (>10 years) (3)
Positive effect	A positive outcome is likely to be achieved either on site or beyond the site boundary in terms of GHG emissions reduction potential (+)	The effect contributes towards reversing the impacts of GHG emissions (+)	Short-term or long-term (+)

Section 6.2 below presents each identified effect and the assessed magnitude of impact in accordance with the nominated effect criteria.

6.2 Effects Assessment

The RMA requires that the term '*effect'* must consider:

- any positive or adverse effect
- any temporary or permanent effect
- any past, present or future effect
- any cumulative effect
- any potential effect of high probability

- any potential effect of low probability which has a high potential impact

The Sunfield GHG effects assessment has considered each of the above qualities of a potential effect, with consideration of the construction and operational phases, and inherent sustainable design measures understood to be embedded within the current proposal. The initial effects assessment is provided below in Table 9 (overpage), presenting the magnitude of each effect based on the assessed scope and influence, reversibility and duration of each impact. The effects listed below represent the key identified potential effects associated with capital and operational GHG emissions. While other additional effects may be associated with the development, this assessment has only identified and noted those listed in the table below.

As noted above, this effects assessment solely considers potential effects associated with capital and operational GHG emissions (climate change mitigation), however, additional positive effects associated with climate change adaptation and resilience are recognised, including but not limited to integrated nature-based solutions and WSUD strategies (particularly in the management of stormwater), reduced impervious area as a result of less hardstand (reduced driveways), and extensive restoration and native planting of the core stream and wetland network. Each of these measures will contribute towards climate change adaptation and resilience within the community.

Table 9 Assessment of Effects

Potential Effect	Emissions	Scope & Influence	Reversibility	Duration	Magnitude
Land clearing releases stored carbon dioxide into the atmosphere.	Capital	0	2	3	5
Embodied emissions associated with carbon intensive materials for construction of the residential and commercial buildings (i.e., concrete, steel, etc).	Capital	0	3	2	5
Embodied emissions associated with carbon intensive materials for construction of the roads and infrastructure including the Sunfield loop road, link roads, internal access roads and utilities (i.e., aggreagtes, concrete, asphalt, steel, etc).	Capital	0	2	2	4
Bulk earthworks (civil enabling works and materials such as cutting and filling areas to create developable lots).	Capital	0	3	2	5
Land use change from predominately rural to extensive revegetated native green space with a focus on integrated nature-based solutions, WSUD measures, and restoration of the core stream and wetland network. The focus on blue and green ecological corridors will act as a natural onsite carbon sink, supporting biodiversity and providing increased resilience.	Operational	+	+	Long-term	Positive
Generation of waste during operations including household waste (residential area) and commercial waste (employment, retail, education zones).	Operational	3	1	3	7
Avoided emissions associated with private travel through reduced reliance on private vehicles for residentials and users of the community due to the innovative 15-minute neighbourhood concept, including accessibility to active and public/shared transport options and proximity to amenities (additionally reducing the living costs associated with owning a private vehicle).	User	+	+	Long-term	Postive
Avoided fuel combustion emissions through prioritising EV's, including the Sunbus autonomous electric shuttle fleet and provision of EV charging infrastructure throughout the community for those residents who do own a private vehicle.	User	+	+	Long-term	Positive
Provision of a solar PV network and battery system within the community, providing renewable energy for residential dwellings and commercial buildings, with excess supply planned to be fed back into the grid.	Operational	+	+	Long-term	Postive

Potential Effect	Emissions	Scope & Influence	Reversibility	Duration	Magnitude
Eliminating emissions associated with gas through excluding gas connections within Sunfield for home and commercial based energy consumption activities.	Operational	+	+	Long-term	Postive
Eliminating capital emissions associated with carbon intensive construction materials through eliminating car parks for every dwelling lot.	Capital	+	+	Long-term	Postive
GHG emissions due to combustion of fuel from construction plant and equipment.	Capital	0	2	1	3
Electricity required for lighting, heating, ventilation, and air conditioning (HVAC) systems for all buildings (residential and commercial) contributes to operational GHG emissions, however, it is understood that the intent is for renewable energy to contribute 100% of the required energy.	Operational	0	1	3	4

As outlined, three potential *minimal* effects, four *moderate* and six *positive* effects have been identified in relation to the construction (capital GHG emissions) and operation (operational GHG emissions) of the Sunfield development. No significant effects have been identified. As previously noted, the effects outlined above represent the key identified potential effects, and other additional effects may be associated with the development.

It is acknowledged that typically transport infrastructure is a significant contributor to capital emissions in a community development, however, Sunfield's car-less design concept significantly reduces the requirement for transport infrastructure and hardstand materials throughout the community, and it is anticipated that the capital emissions associated with transport infrastructure will be reduced compared to a traditional community development. Therefore, embodied emissions associated with construction of the roads and infrastructure has been assessed as a *minimal* effect (though recommendations have been provided to further minimise impacts associated with the construction materials).

7 Recommendations

Recommendations in alignment with the mitigation hierarchy as defined by New Zealand Association for Impact Assessment (NZAIA), have been developed for consideration at future detailed design stages, in order to avoid and minimise capital upfront emissions, and further reduce operational energy demand. In addition, as previously stated, a comprehensive GHG emissions assessment (including sources which are not able to be quantified at this time due to the preliminary nature of project information) is recommended at future project stages when further design detail is available.

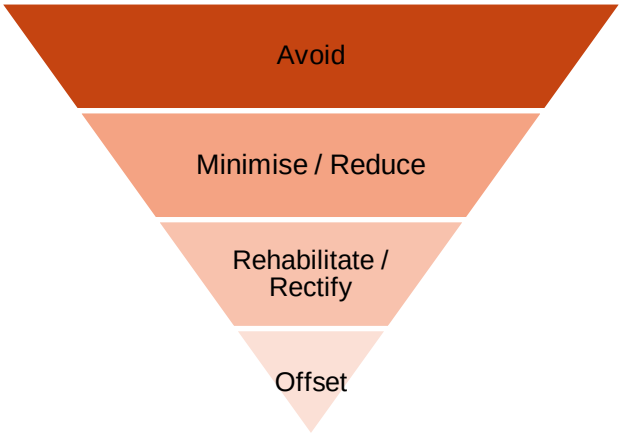


Figure 19 Mitigation hierarchy

7.1 Capital Emissions

As previously noted, the upfront capital emissions account for the largest proportion of Sunfield's total estimated GHG footprint, with Product (A1-A3) and Construction (A4-A5) being the most emissions-intensive components. It is essential to clarify that these emissions are inherently linked to the construction and building process; however, there is opportunity to influence and reduce these emissions, including implementation of the recommendations provided in Table 10.

Table 10 Recommendations – Capital Emissions

Activity	Recommendations
Land clearing releases stored carbon dioxide into the atmosphere as vegetation is removed	• Aim to minimise the extent of the site footprint, and enhance the post-construction carbon sequestration potential through strategic planting of terrestrial and riparian vegetation.

Activity	Recommendations
Embodied emissions associated with carbon intensive materials for construction of buildings (i.e., concrete, steel, etc) (these recommendations also apply to embodied emissions associated with carbon intensive materials for construction of infrastructure and roads)	• Aim to avoid and minimise additional / redundant infrastructure or building components or elements within the design, optimising space and extent of new assets required. • Specify low carbon material requirements within the design such as reused / recycled material content. • Incentivise the construction contractor to further optimise reuse of site won materials as far as possible, including measures such as embedding sustainability requirements within the procurement process, and prioritising reuse of materials on site through a Resource Efficiency & Management Strategy or similar. • Source locally, ensure materials are sourced from local suppliers to reduce transport / haulage emissions. • Embed circular economy principles within all design elements, in order to eliminate waste, extend asset design life, and enable reuse at the end of life. • Focus on durable and flexible design for longevity and adaptability (extend the building's lifespan, reducing the need for future renovations or demolitions). • Engage and collaborate with suppliers to identify opportunities for use of innovative, sustainable materials and products. • Nominate responsible person within design and construction team to identify, oversee and implement sustainability principles and strategies.
Bulk Earthworks (civil enabling works such as cutting and filling areas to create developable lots)	• Utilisation of site won materials will reduce the volume of imported material required, minimising the embodied emissions footprint, in addition to reducing haulage emissions.
Diesel usage in construction plant and equipment	• Specify use of biodiesel or renewable diesel in construction plant and equipment to reduce emissions associated with diesel.

7.2 Operational Emissions

Best practice strategies such as solar PV and sustainable housing design have been considered and prioritised in the current strategy, however, there is opportunity to further avoid and reduce operational energy demand and impact, particularly in relation to industrial and commercial areas. Recommendations are provided below in *Table 11*.

Table 11 Recommendations – Operational Emissions

Activity	Recommendations
Electricity required for lighting, heating, ventilation, and air conditioning (HVAC) systems for all buildings (residential and commercial) contributes to operational GHG emissions.	• Although renewable energy will be provided throughout the community, reducing heating and cooling loads through prioritising passive design strategies and high-performance building design for all buildings will reduce energy demand.

Activity	Recommendations
Generation of waste during operations including household waste (residential area) and commercial waste (employment, retail, education zones).	• Embed circular economy principles within the built environment design to eliminate waste and reuse resources, including through educating residents, visitors and employees. • Ensure dedicated waste facilities, enabling waste streams to be separated and appropriately reused, recycled or composted. • Consider onsite waste to resource recovery schemes to avoid and minimise methane emissions from waste (i.e.onsite capture of biogas can be used to generate onsite renewable energy).

7.3 Residual Effects

A residual effect is defined as the remaining impact after appropriate mitigation and treatment measures have been implemented. An assessment of the residual (remaining) magnitude has been undertaken for all initial *moderate* effects within Table 12 below. It is important to note that the residual magnitude for each effect outlined below are based on the assumption that all recommendations outlined in the preceding section will be adopted (at a minimum).

Table 12 Residual magnitude of effects

Effect	Emissions	Residual Magnitude
Land clearing releases stored carbon dioxide into the atmosphere as vegetation is removed	Capital	Minimal
Embodied emissions associated with carbon intensive materials for construction of buildings (i.e., concrete, steel, etc)	Capital	Minimal
Bulk Earthworks (civil enabling works such as cutting and filling areas to create developable lots)	Capital	Minimal
Generation of waste during operations include household waste (residential area) and commercial waste (employment, retail, education zones).	Operational	Minimal

As outlined, all initial *moderate* effects are assessed as being mitigated and reduced to a *minimal* magnitude, following the application of recommended mitigation measures.

8 Conclusion

This Sustainability and GHG emissions assessment provides an early analysis of Sunfield's alignment and contribution towards global objectives and trends in sustainable community development, and relevant national and regional GHG policy. In addition, an estimated range of capital and operational GHG emissions (based on information available at this design stage) has been presented.

The GHG assessment results highlight the proportional significance of the upfront capital GHG emissions associated with the construction of the residential and commercial buildings. Emphasis should be placed on the fact that capital emissions arise from construction activities and materials, and represent a significant opportunity for reducing the overall emissions footprint through the recommended reduction strategies. Sunfield's inherent sustainable design measures including facilitation of behaviour change through eliminating private vehicles within the community and the renewable energy network will contribute towards GHG emission reduction targets.

Overall, the innovative sustainability initiatives proposed for Sunfield align with global and national GHG emission reduction targets. The mandatory solar PV and battery network will provide clean, renewable energy for homes and businesses, eliminating reliance on fossil fuels. The Sunbus autonomous electric shuttle fleet, combined with extensive EV charging infrastructure and car-less design, will contribute to minimised transport-related emissions. The 15-minute neighbourhood design, along with mixed-use development and over 11,000 local jobs, will further reduce emissions by minimising the need for long commutes. Additionally, the elimination of gas connections and the reduced use of carbon-intensive construction materials, such as those associated with traditional car parks, contribute to a lower embodied carbon footprint. Collectively, these measures position Sunfield as a model for low-carbon, future-proofed urban development.

Recommendations have been developed in order to inform future strategic decision-making at subsequent design stages, and it is anticipated that these recommendations will be further considered and integrated as part of the design development process. In particular, a comprehensive GHG emissions assessment is recommended to be undertaken at subsequent detailed design stages, once a more granular level of design detail is available and any genuine GHG emission reductions can be quantified.

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Appendix A

A.1 Alignment with global sustainable trends and policy

Sustainable Trend Detail	Project Detail	Global Sustainable Trend							Policy Alignment
		Urban Planning & Post Pandemic Localisation	Human Centred Design	Climate Mitigation and Adaptation At A City Scale	Connection and Liveability	Healthy and Active Living	Biodiversity and Ecological Conservation	Resilient and Future Focused	
A.1.1 Renewables	Most of the energy requirements of Sunfield will be covered with onsite solar power throughout the community. WLL has partnered with Lightforce to create the Sunfield renewable energy strategy for the master planned community.								ACP Action EN3 TERP Action 7.
A.1.2 15-minute neighbourhood	The neighbourhood is designed to provide residents access to most, if not all, resident needs within a short walk or bike ride from their home, including schooling, employment, medical services, restaurants and bars, recreational spaces, retail, and food supplies.								TERP Action 1. AUP B10.2
A.1.3 Mixed Use Development	4,000 homes, consisting of 3,400 individual homes and 3 retirement villages of approximately 600 independent living units and care beds.								ACP Actions B7 & T6. AUP B2.2, B2.5; NPS-UD
A.1.4	460,000 sqm of employment, retail, healthcare and education buildings. Permanent jobs for over 11,000 people provided over								AUP B2.8

Sustainable Trend Detail	Project Detail	Global Sustainable Trend							Policy Alignment
		Urban Planning & Post Pandemic Localisation	Human Centred Design	Climate Mitigation and Adaptation At A City Scale	Connection and Liveability	Healthy and Active Living	Biodiversity and Ecological Conservation	Resilient and Future Focused	
Work Local, Employment Creation and Support	57 Ha. A further 5 retail hubs located throughout the community. 2km from the Papakura and Takanini employment areas.								NPS-UD Objective 1, Policy 1 and 3; NZUDP
A.1.5 Access to education	Access to one school, approximately 4 ha, in the development.								AUP B2.2.2., 2.6.1 and B6.2 NPS UD Objective 1, Policy 1 and 6 RMA
A.1.6 Ecological Enhancement & Conservation/ Kaitiakitanga	An extensive restoration and native planting of the core stream and wetland network. The Māori world view of Kaitiakitanga acknowledges the responsibility and the protection of the natural environment by Mana Whenua. By embedding a strong green and blue open space network into the concept masterplan celebrating water, restoring waterways and reflecting the wider landscape, the masterplan seeks to connect people with nature. Restoration of the existing waterway is a catalyst for creating a strong green buffer to the east of Sunfield that will establish an ecological corridor linked to the green network to enhance biodiversity throughout the development.								ACP Actions B8, N2, N3 & N4 ERP Actions 4.1, 4.2 & 14.2.3;

Sustainable Trend Detail	Project Detail	Global Sustainable Trend							Policy Alignment
		Urban Planning & Post Pandemic Localisation	Human Centred Design	Climate Mitigation and Adaptation At A City Scale	Connection and Liveability	Healthy and Active Living	Biodiversity and Ecological Conservation	Resilient and Future Focused	
A.1.7 Remediation	Wai Mauri Stream Remediation. The ecological value of this natural inland wetland has been assessed by Bioreseach as 'Low'. The site has been deemed suitable for significant remediation, enhancement and restoration								ACP Actions B8 & N3.
A.1.8 Inclusive Design	The diversity of lifestyle choices within Sunfield will attract a wide range of residents, whether they be first home buyers, families, renters or retirees, who will contribute to a thriving diverse community. Three retirement villages of approximately 4ha each in size are provided for in locations which are easily accessible to community transport and mobility network. The retirement villages will be permeable and integrated with the wider masterplan								NPS-UD; RMA
A.1.9 Car-less living	A community designed to enable “car-less” living. Without the requirement for extensive roading and individual garaging in the development, more space is freed up for warmer, drier homes in Sunfield. The benefits of car-less living are many, and a reduction in internal combustion engine vehicles will be a significant component in achieving New Zealand’s goal of carbon neutrality by 2050. Private vehicle ownership will be restricted to a ratio of 1 car per 10 housing units. Visitor parking will be provided at the same								ERP Actions 10.1.1 & 10.1.2; ACP Actions T1 & T4; and TERP Actions 1, 4 & 5.

Sustainable Trend Detail	Project Detail	Global Sustainable Trend							Policy Alignment
		Urban Planning & Post Pandemic Localisation	Human Centred Design	Climate Mitigation and Adaptation At A City Scale	Connection and Liveability	Healthy and Active Living	Biodiversity and Ecological Conservation	Resilient and Future Focused	
	ratio. Parking for both residents and visitors will be provided at the Community and Mobility Hubs, all of which are located on the Sunfield Loop.								
A.1.10 Access to public transport	2km from the suburban rail network southern line of the Papakura station and Takanini station which will be serviced by the Sunbus autonomous electric shuttle fleet. Sunfield autonomous electric shuttle that runs continually to link with the train station, the central Sunfield Village, small neighbourhood hubs, and will stop anywhere in between.								TERP Action 1. AUP B10.2 & B3.3 ERP Actions 10.1.1 & 10.1.2
A.1.11 Healthy homes	Without the requirement for extensive roading and individual garaging in the development, more space is freed up for warmer, drier homes. Warmer, drier homes can have significant health benefits for those people on low incomes, including increased comfort, reduced time off school or work, fewer GP visits, fewer hospital admissions for circulatory etc.								ERP Action 11.1.1 & 12.1.3.
A.1.12 Live Local	Sunfield supports a shift away from travel and dependence on private motor vehicles by providing local social, recreational, education, and employment opportunities close to, or within, residential areas. Within Sunfield there will be a school, local employment, a main centre with retail and community and								AUP B2.2.1 & B2.2.2; B3 NPS-UD Objective 1, Policy 1 and 3; NZUDP

Sustainable Trend Detail	Project Detail	Global Sustainable Trend							Policy Alignment
		Urban Planning & Post Pandemic Localisation	Human Centred Design	Climate Mitigation and Adaptation At A City Scale	Connection and Liveability	Healthy and Active Living	Biodiversity and Ecological Conservation	Resilient and Future Focused	
	medical services, smaller hubs for community retail, bike parking, shared cars and visitor parks.								
A.1.13 Active Transport	The Sunfield concept masterplan provides a clear framework that will enable a dramatic reduction in car dependence and will promote healthier transport options: Cycle lanes, walking and shared lanes. Provision of 32m wide 'movement corridor' that includes cycle lane, footpath and community transport through the Sunfield Loop. Provision of pedestrian lanes. 2m Building setback from the laneway with a minimum building to building dimension of 10m.								ERP Actions 10.1.1 & 10.1.2; ACP Actions T1 & T4; and TERP Actions 1, 4, 5, 7
A.1.14 Stormwater management	A consolidated approach to stormwater management provides opportunity for improved water quality and resilience. It can be combined with water-sensitive urban design in the public realm and on-site water tanks for improved benefits. Water will be collected from the hub and village rooftops, enabling water storage and water supply for shared spaces throughout Sunfield. It is understood that of the total 244ha, approximately 47ha is set aside solely for stormwater management and will consist of predominantly open watercourses and riparian planting								ACP Actions B2 & B8. NPS FM Objective 1, Policy 3 and 10 RMA AUP E10
A.1.15	The site employs Water Sensitive Urban Design ("WSUD") approach to the engineering design of the three waters strategy								ACP Actions B2 & B8.

Sustainable Trend Detail	Project Detail	Global Sustainable Trend							Policy Alignment
		Urban Planning & Post Pandemic Localisation	Human Centred Design	Climate Mitigation and Adaptation At A City Scale	Connection and Liveability	Healthy and Active Living	Biodiversity and Ecological Conservation	Resilient and Future Focused	
Water sensitive design	for Sunfield. WSUD is a land planning and engineering design approach which integrates the urban water cycle - including stormwater, groundwater and wastewater management and water supply - to minimise environmental degradation and improve aesthetic and recreational appeal. Sunfield's WSUD strategy incorporates ground water recharge to the peat subgrade soils, reduced impervious area (due to reduced requirements for vehicle-related hardstand) and large scale attenuation of stormwater (post development flows are held at pre-development flows).								ACP Actions N2 & N3
A.1.16 Gass less living/ Electrified buildings	Excluding gas connections within Sunfield for heating and cooking further eliminates emissions and air pollution within homes and commercial sites, benefiting the health and wellbeing of residents, reducing environmental impact, and avoiding likely increases to gas bills as the cost of carbon increases. All homes / buildings are 100% electric.								NPS-REG A & C1 CCR 5Q AUP B6.2.1; B9.3.2
A.1.17 Green Space	With more green areas, Sunfield residents will also have access to community gardens, supporting self-sufficiency and community interaction. Neighbourhood Park: These are small 0.2-0.5ha parks, within a 400m walk from home								ACP Actions B8, N2 & N3. AUP B2.7; POS

Sustainable Trend Detail	Project Detail	Global Sustainable Trend							Policy Alignment
		Urban Planning & Post Pandemic Localisation	Human Centred Design	Climate Mitigation and Adaptation At A City Scale	Connection and Liveability	Healthy and Active Living	Biodiversity and Ecological Conservation	Resilient and Future Focused	
	Sunfield Park: This is a suburb park, centrally located. range of recreational facilities such as sports fields/courts, a destination playground, outdoor gym and informal open spaces. Centralised Stormwater Park: With an integrated and naturalised design approach, it will enable the park to be a space for recreation and respite, whilst also having significant ecological function and value. Wai Mauri Stream Park: This corridor will be re-vegetated with the indigenous species that once grew on the site. Wetland Park: Nestled on the site's northwestern boundary and is the catchment for the stormwater system that borders the northern and eastern boundaries of Sunfield								
A.1.18 Lower Living Costs	Sunfield residents will experience lower living costs from not owning and servicing a car, and reduced energy costs from solar energy making up most of the energy supply.								NPS-UD; HASHA; AUP B2.4
A.1.19 Climate Change and natural hazard risk assessment	The primary risk and only known natural hazard relating to the Property is the matter of the flood plain which affects the Property. A comprehensive and significant engineering solution has been developed to manage the stormwater that affects the Property								AUP B10.2; ERP

Sustainable Trend Detail	Project Detail	Global Sustainable Trend							Policy Alignment
		Urban Planning & Post Pandemic Localisation	Human Centred Design	Climate Mitigation and Adaptation At A City Scale	Connection and Liveability	Healthy and Active Living	Biodiversity and Ecological Conservation	Resilient and Future Focused	

Abbreviations: RMA - Resource Management Amendment Act 2020; **CCR** - Climate Change Response Act 2002; **ERP** - Aotearoa New Zealand Emissions Reduction Plan / Te hau mārohi ki anamata - Aotearoa New Zealand's first Emissions Reduction Plan, 2022; **NPS-UD** - National Policy Statement on Urban Development, 2020; **NPS FM**- National Policy Statement for Freshwater Management 2020; **IMP** - Iwi Management Plan, 1995; **ACP** - Auckland Climate Plan 2020; **TERP** - Auckland Transport Emissions Reductions Plan 2022; **AFDS** - Auckland Future Development Strategy 2023-2053; **AUP** - Auckland Unitary Plan 2011; **HAT** - Healthy Auckland Together; **HASHA**: Housing Accords and Special Housing Areas Act 2013; **NPS-REG:** National Policy Statement for Renewable Electricity Generation 2011; **NZUDP**: New Zealand Urban Design Protocol (2005)

A.2 Modelling Assumptions

A.2.1 Capital & Operational Emissions

Asset level carbon intensity benchmarks for building were derived from *Buildings Embodied Carbon Measurement for Infrastructure Technical Guidance, July 2024* in preparing the range of capital emissions presented in Section 5.

Transport infrastructure was estimated using the Waka Kotahi, Project Emissions Estimation Tool (PEET), version 4.0 for first order estimates.

The data used for this reports GHG assessment is detailed in the Table below. Note that this data does not need to be exact, but more an indicative representation of what information is available at this design stage. These values will change as the development progresses throughout the design phase. It would be recommended to update the GHG Assessment results at a later stage once more detailed design information is available.

Item	Figure	UoM
Dwellings	85	ha
Number of dwellings - Total	3,800	No. of homes
Dwellings (as broken down below)	3400	No. of homes
50% Free Standing	1600 224000	No. of homes m^2
50% Terrace	1600 160000	No. of homes m^2
Retirement Village Units	600 7800	No. of homes m^2
Employment Zone	46	ha
Office	48,300	m^2
Warehouse	296,700	m^2
Retail		
Town Centre	7.5	ha
Local Hub	6	ha
Other		
Early Childhood facilities	2,000	m^2
Communal Parking	20,000	m^2
Town Centre	8	ha
Precinct Area	76,000	m^2
Building Area	53,800	m^2
Total Healthcare	2	ha
Precinct Area	22,000	m^2

Building Area	13,200	m^2
Total Education	4	ha
Precinct Area	40,000	m^2
Building Area	16,800	m^2
School	6,000	m^2
Total roads	7301245.5	Cost
Total road area	40932	m^2
Total road length	7580	m
Seal width	5.4	m

The GHG modelling excludes a range of items due to the stage of design and design detail available at this stage. A list of exclusions is outlined below (but is not limited to):

- Detailed materials: Detailed material and component analysis for buildings.
- Infrastructure components: Earthworks, stormwater/drainage infrastructure etc.
- Structural: Detailed structural elements that are not known at master planning stage
- Landscaping: Vegetation and planting etc.
- Small-Scale Infrastructure and Ancillaries: street furniture, minor landscaping, and other non-critical components.
- Uncertain Future Technology Uptake: Modelling may exclude future advancements in energy efficiency, renewable energy, or transport technology that are speculative.
- Tenant-Specific Fit-Out Emissions: Individual customisation of homes or community spaces, such as appliances and furnishings.
- Upstream Emissions of Energy Production: Full lifecycle emissions from fossil fuels or renewables unless grid factors include these.
- Embodied Carbon from Imported Materials: If detailed supply chain data is unavailable, international materials' emissions may be excluded.

With every community, we redefine what's possible.

Stantec is a global leader in sustainable architecture, engineering, and environmental consulting. The diverse perspectives of our partners and interested parties drive us to think beyond what's previously been done on critical issues like climate change, digital transformation, and future-proofing our cities and infrastructure. We innovate at the intersection of community, creativity, and client relationships to advance communities everywhere, so that together we can redefine what's possible.