Proposed Plan Change I: Increasing housing supply and choice

Climate Change Report

This document was prepared by Palmerston North City Council, XXX Division.

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Executive Summary

This report examines the impact of the creation of a medium density residential zone in Palmerston North on greenhouse gas emissions and investigates mechanisms for incorporating resilience to the predicted impacts of climate change within these developments.

Climate modelling projections indicate that by 2090 there will be more than twice as many hot days and whilst average rainfall decreases slightly it becomes more intense. Increased heat in combination with more hard surfaces could create cumulative effects such as the 'Urban Heat Island' effect with implications for public health. Increased rainfall in combination with more impermeable surfaces could increase pressure on the urban stormwater network leading to an increased risk of localised flooding.

Multi-unit developments use fewer materials per unit and create opportunities for re-using waste materials so that these typologies produce approximately half the greenhouse emissions of equivalent detached single unit typologies. This is sufficient to justify the promotion of alternate typologies with no other benefits. The location of medium density zones near to public and active transport networks and any rules that encourage energy saving behaviors amongst residents add additional benefits.

In order to mitigate the expected heat effects proposals to require shading of north facing walls and outdoor living areas are included in this report.

The primary mechanism for mitigating surface water is to avoid developing areas at high risk of frequent flood events. Where development occurs, on site rules to limit impermeable surfacing and provide sufficient rainfall intercepts and detention options are explored in order to mitigate the expected increases in rainfall intensity resulting from climate change.

1 Introduction

This memorandum has been prepared by David Watson, Senior Climate Change Advisor at Palmerston North City Council. Its purpose is to inform the preparation of proposed Plan Change I: Increasing housing supply and choice (PC:I).

1.1 Purpose of Plan Change I: Increasing housing supply and choice

Policy 5 of the National Policy Statement on Urban Development 2020 ('NPS-UD') requires Palmerston North City Council to make changes to its operative District Plan to enable residential heights and density of urban form commensurate with the level of accessibility by existing or planned active or public transport to a range of commercial activities and community services or the relative demand for housing in that location. This change is called Proposed Plan Change I.

The Council's intention is that Proposed Plan Change I will add a new Medium Density Residential Zone (MDRZ) to the District Plan, which will apply in particular parts of the city. It will enable housing up to 3 storeys high and 3 homes (residential units) per site as a permitted activity, subject to compliance with permitted activity conditions relating to bulk and location, residential amenity and coverage.

For developments of more than 3 residential units resource consent would be required, but the overall intent of the zone and changes to the Plan would be to encourage medium density development.

Outside of the proposed Medium Density Residential Zone, the Council intends making some changes to how the operative multi-unit housing rules are interpreted and applied.

1.2 Key assumptions

The 'Our Future Your Climate' National Institute of Water and Atmospheric Research (NIWA) downscaled projection scenarios for Whanganui also relate to Palmerston North.

The outputs of the IPCC fifth assessment report (AR5)[1] downscaled climate change projections for the Manawatu-Whanganui region published in 2018 and the updated IPCC sixth assessment report (AR6)[2] downscaled projections published in September 2024 are approximately equivalent in practice; hence, using the AR5 climate change projections is appropriate for current technical assessments.

Buildings being compared are built to the current minimum Building Code requirements and variations are entirely due to typology and spatial factors.

No changes will be made to the Building Code between now and 2050 that would change the relative efficiency of different housing types (e.g. H1 insulation requirements) given assumption 3.

Features included in construction and landscaping designs for the purposes of climate mitigation/adaptation will be well maintained and will continue to provide benefits for the whole life of the building.

2 Climate change projections for Palmerston North

2.1 What are the projections telling us about the key effects of climate change?

Over 3100 socioeconomic, emissions, and sectoral transformation scenarios were used by the AR6 working groups to project historical climate data into the future. These scenarios have different purposes and make different assumptions about their inputs, such as the rate of carbon dioxide emissions over the next 20 years, how economies will grow and change and how technology will develop and be adopted.

In order to make a risk-based assessment of the proposed plan change this memorandum uses Shared Socioeconomic Pathway (SSP) 2-4.5. This is a 'Middle of the road' scenario which

1 Intergovernmental Panel on Climate Change 2014: Climate Change 2014: Synthesis Report. Contribution of Working Groups I, II and III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Core Writing Team, R.K. Pachauri and L.A. Meyer (eds.)]. IPCC, Geneva, Switzerland, 151 pp.

2 Intergovernmental Panel on Climate Change, 2023: Sections. In: Climate Change 2023: Synthesis Report. Contribution of Working Groups I, II and III to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change [Core Writing Team, H. Lee and J. Romero (eds.)]. IPCC, Geneva, Switzerland, pp. 35-115, doi: 10.59327/IPCC/AR6-9789291691647

assumes that the world follows a path in which social, economic, and technological trends do not shift markedly from historical patterns. In this way, we hope to highlight areas of concern and indicate likely impacts as a basis for mitigation planning.

Currently available data indicates that Palmerston North will get warmer and drier on average, but with increased rainfall intensity as a result of climate change, as shown in Table 1. Extrapolating average climatic data over 20-year periods to predict what the weather will be like in any one specific year is beyond the scope of current models and so climate variables are expressed as ranges.

Table 1: Projected changes in climatic variables between 1995–2014 (2005), 2021–2040 (2030), 2041-2060 (2050) and 2080–2099 (2090) for Palmerston North City.[3]

Climate Variable from SSP2-4.5[4]	2005	2030	2050	2090
Average Temperature	13.4°C	+0.6°C	+1.1°C	+2.0°C
Average number of days per year over 25°C	20 days	+7.1 days (2.5 to 8.9)	+16.7 days (7.5 to 20.2)	+30.7 days (14.2 to 36.4)
Annual precipitation (in %)	962.3mm	+0.3% (-0.1 to +1)	-0.1% (-0.8 to +0.5)	-0.8% (-1.7 to +0.3)
Expected rainfall intensity for a 1 in 10 year event lasting 1 hour (mm/m²)	22.4mm (-2.4 to +2.4)	n/a	24.4	27.2
Average number of days per year with over 25mm of rain	4 days	+0.5 days (+0.2 to +0.9)	+0.6 days (+0.4 to +0.7)	+0.9 days (+0.7 to +1.1)

Due to the latest scenarios being published in September 2024, other technical reports use the AR5 data published in 2014 and downscaled from global data to a New Zealand context in 2018 (see Table 2 below). From this dataset the RCP6.5 scenario was chosen as it includes a mix of emissions mitigation efforts and sustainable development strategies. This has been used for modelling and referencing to reflect the most likely outcomes of climate change as a basis for asset planning, including for the stormwater assessment supporting PC:I.[5]

3 Derived from statistical downscaling, at SSP 2-4.5. Values in brackets indicate the range of possible results from different models. Expected rainfall intensity derived from HIRDS data[3] based on Representative Concentration Pathway (RCP) 6.0.

4 Climate projections summary dashboard | Ministry for the Environment

5 PNCC owns a TUFLOW stormwater model that is used to identify potential flooding of existing development as at 2019. The model has been used to assess the likely flooding predicted in the 10-, 50- and 100-year ARI events, with the infrequent events accounting for climate change using NIWA's RCP 6.0 climate change scenario.

Table 2 - Projected changes in climatic variables between 1986–2005 (1995), 2031–2050 (2040) and 2081–2100 (2090) for the Manawatū-Whanganui (Whanganui) region.[6]

Climate Variable from RCP6.5	1995	2040	2090
Annual mean temperature (in °C)[7]	13.4°C	+1.1°C (0.6 to 1.6)	+3.1°C (2.2 to 4.4)
Average number of days per year over 25°C[6]	20 days	+8 days	+52 days
Annual precipitation (in %)[8]	962.3mm	+1% (-5 to +7)	+1% (-11 to +10)
Expected rainfall intensity for a 1 in 10 year event lasting 1 hour[9] (mm/m^2)	23.7mm	+2.7mm	+7.1mm
Average number of days per year with over 25mm of rain[6]	4 days	+1 day	+1 day

The data in Table 2 refers to the AR51 data published in 2016 and has been downscaled to fit a New Zealand context. Some data is not directly available for Palmerston North, so Whanganui or Manawatu-Whanganui regional data has been substituted.

2.2 What effect will this have on people living in Palmerston North?

Urban areas are particularly affected by increased heat and rainfall due to large areas of impermeable surfaces with high heat retention. Palmerston North is also affected by catchment-scale rainfall through its rivers and streams.

The projected increase in 'Hot Days' includes increases in the duration of periods of hot weather and greater variability between seasons. During extended heatwaves or droughts buildings and hard surfaces retain more heat and cool down more slowly than vegetation leading to the 'Urban Heat Island Effect' with implications for public health, energy use and infrastructure maintenance.

Whilst projections do not indicate significant changes in overall rainfall volume, the frequency and intensity are likely to change resulting in more variation between seasons and greater impacts from rare events like rainstorms. Increases in the volume, frequency and/or duration of heavy rain or storm events, especially where this is an infrequent or irregular event, will result in higher surface water flows than currently experienced. This will require infrastructure interventions to prevent localised flooding if there is insufficient capacity within

6 Derived from statistical downscaling, at RCPs 6.5. Values in brackets indicate the range of possible results from different models.

7 Ministry for the Environment 2018. Climate Change Projections for New Zealand: Atmosphere Projections Based on Simulations from the IPCC Fifth Assessment, 2nd Edition.

8 Our Future Climate New Zealand, NIWA, 2018 (based on Whanganui data)

9 High Intensity Rainfall Design System V4, NIWA, 2018 (based on Palmerston North data)

the network. It is also likely to require a long-term risk-based approach to maintenance to ensure network capacity is available when needed.

3 What are the projections telling us about the implications for living in higher-density urban areas?

3.1 Infrastructure will need increased capacity and resilience:

- Projected increases in the intensity of rainstorms will require additional short-term detention capacity to avoid public health issues, environmental damage and property damage from flooding. This is particularly true of catchment scale events where even short-duration rainstorms will accumulate as they move downstream;

- Any increased intrusion of stormwater into wastewater processing will result in damage to infrastructure or a greater risk of environmental damage from emergency discharges into the river;

- Consecutive annual decreases in overall rainfall will affect potable water supplies or increase reliance on bore water;

- Road surfacing will need to be designed to withstand more intense rainfall, ideally with reduced heat retention; and

- Transport infrastructure (e.g. bridges) will need to be able to withstand more variable flow rates in rivers and streams, potentially including increased floating debris or bank shrinkage.

3.2 Buildings and open spaces may need to be designed to cope with future climate-related risks:

- Buildings, on the margin, will need to reduce heating and heat retention, take advantage of passive cooling and minimise day by day accumulation of heat during extended hot periods leading to the urban heat island effect;

- Landscaping will need to account for longer dry periods containing infrequent, high-intensity rainfall events to prevent overburdening the surface water system; and

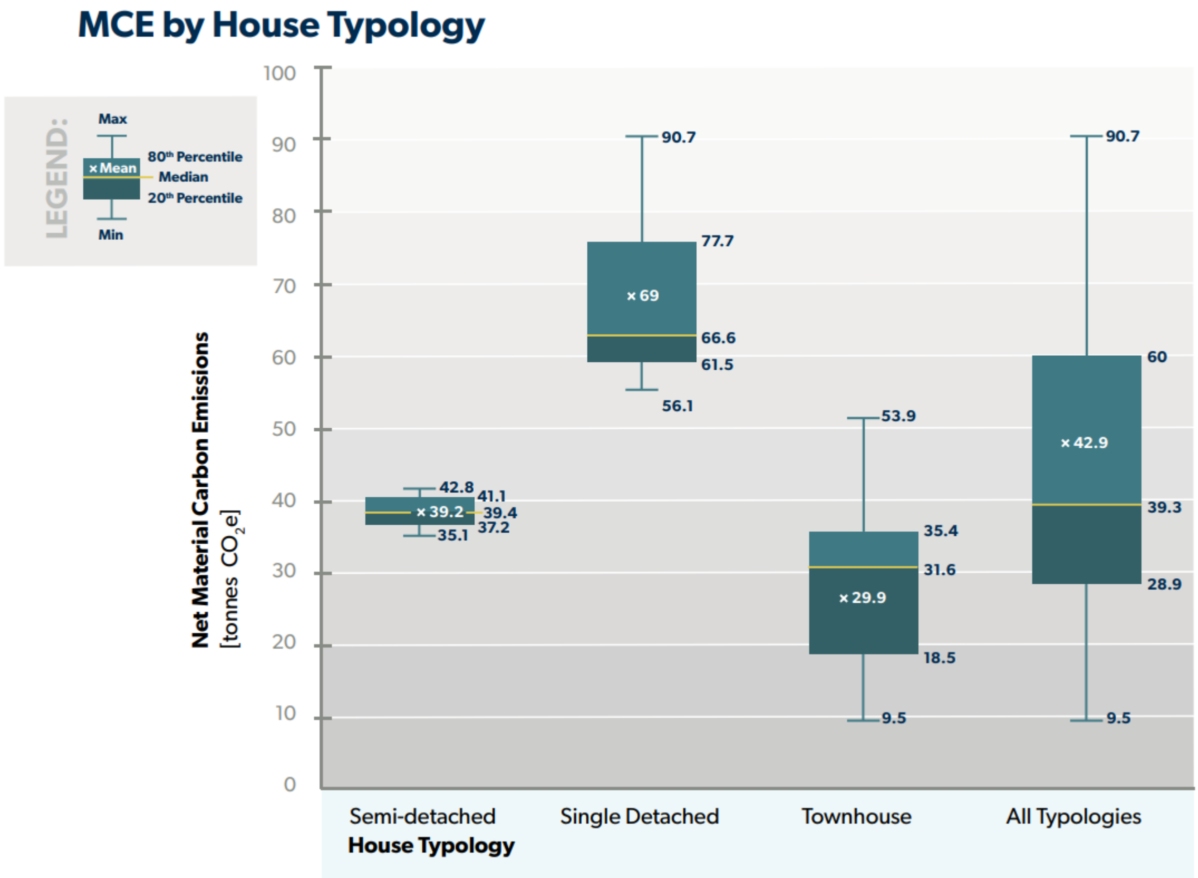
- Parks and green infrastructure will see changes including long-lived plants and trees requiring improved water retention, increased water use and more need for active maintenance. Open spaces may also need to act as stormwater detention basins to reduce the impact of more intense rainstorms.

4 How can development in the medium density housing zone support reductions in greenhouse gas emissions?

The effects of climate change will vary depending on the volume of greenhouse gas emissions that are put into the atmosphere. Emissions primarily come from the materials used in construction (embedded emissions), how the building is used (operational emissions) and the behaviour of residents (e.g. transport choices). Minimising emissions from the construction, operation and disposal of buildings alongside providing opportunities for residents to reduce their behavioural emissions will help reduce climate impacts in the long term. Note however, that the net emissions impact of changes is relatively small compared to what might be expected from intensification in larger metropolitan areas where vehicle emissions can be considerable. Furthermore, since the emissions categories discussed below are covered by the NZ Emissions Trading Scheme, reductions in these areas can be expected to be offset by equivalent emissions elsewhere in the New Zealand economy. As such, emission reductions should not be considered a major driver through this process.

4.1 Embedded Emissions

Research carried out by Passive Buildings Canada and Builders for Climate Action[10] compared the estimated Material Carbon Emissions of 59 house plans for single detached, semi-



[10] Magwood, C., Bowden, E., Trottier, M. Emissions of Materials Benchmark Assessment for Residential Construction Report (2022). Passive Buildings Canada and Builders for Climate Action.

detached and townhouses built between 2017 and 2020. This equates to approximately 503 as-built homes.

Figure 1: Net Material (embedded) Carbon Emissions for three housing typologies

This would indicate that (following Canadian building standards) a 50%+ saving in embedded emissions is possible through changes in building typology. It is even possible in unusual cases to achieve a net negative embedded carbon rating by using largely biogenic materials[11].

BRANZ Bulletin 671 states "Construction of a typical new house in Aotearoa New Zealand generates an average of 4 tonnes of waste, and most of this is trucked to landfills or cleanfills. Construction and demolition waste makes up a third to a half of all waste going to landfills and cleanfills.[12]

Modular building techniques and designing for recycling and reusability allow for simple replacement of damaged parts and easier reclamation and reuse of materials at end of life, helping reduce emissions from demolition and decomposition of organic construction material in landfills.

4.2 Operational Emissions

In 2023 residential consumption surpassed industrial consumption to become the largest sector of electricity consumption in New Zealand[13] consuming approximately 16% of national consumer energy[14]. Average residential electricity consumption per household in New Zealand in 2023 was 7033.33kWh increasing to 7,088.29kWh in 2024.

BRANZ provides a series of 'reference buildings' in their LCAQuick spreadsheet that act as case studies of the carbon footprint of different housing types[15]. If calculated over a 90-year service life, the operational (energy and water) component is approximately double the whole-of-life embodied component.

Analyses of household energy consumption in the U.S. consistently find that single-family detached houses consume more energy, after controlling for other variables including house size, climate, and income.[16] "The amounts of delivered energy use for space heating, cooling, and all other uses are strongly related to the physical characteristics of housing units. Old houses are less energy efficient than new ones. Detached houses require more energy than attached ones. Compared with households living in multifamily units, otherwise comparable households living in single-family detached units consume 54 percent more energy for space

11 Defined as materials from a biological source such as wood, wool or other natural fibres

12 ISSN 1178-4725 (Print) 2537-7310 (Online) BRANZ Bulletin Issue 671: Reducing Construction and Demolition Waste

13 Energy in New Zealand 2024 Energy in New Zealand 2024 (mbie.govt.nz)

14 Consumer energy is the amount of energy consumed by final users. It excludes energy used or lost in the process of transforming energy into other forms and in bringing the energy to the final consumers. For example, natural gas is a primary energy source, some of which is transformed into electricity, of which some is lost in transmission to consumers.

15 Study Report SR418 New Zealand whole-building whole-of-life framework: LCAQuick v3.4 – a tool to help designers understand how to evaluate building environmental performance

16 Linking Housing Policy, Housing Typology, and Residential Energy Demand in the United States | Environmental Science & Technology (acs.org)

heating and 26 percent more energy for space cooling"[17]. Similar studies across Europe found similar results, although the variety of building typologies is much greater.

In addition to building form the choice of insulation, low-energy appliances, ventilation, heating and hot water provision and the inclusion of solar systems can help reduce the financial cost and carbon emissions from operating a building over its lifespan. This is the foundation of the operational emissions cap proposed by MBIE in the 2020 Transforming Operational Efficiency report.[18] Australia has implemented the Nationwide House Energy Rating Scheme (NatHERS) system of energy efficiency ratings based also based on these principles

4.3 Behavioural Emissions

Short car trips under two kilometres make up nearly a third of all car trips in New Zealand[19], more than a billion trips each year. Transport emissions from occupants can be affected by a development's proximity to public and active transport infrastructure and can be reduced by site selection, walkability and signposting. People are most likely to change their travel behaviour at the point at which they move to a new house (see below). By delivering more housing specifically adjacent to public and active transport infrastructure residents could be encouraged to change their behaviours and reduce their transport emissions.

A study from the city of Ghent (Belgium)[20] found that moving to a more urban neighborhood significantly improves attitudes towards public transport use, cycling, and especially walking. For commute trips, the effect of changes in neighborhood on attitudes is mainly direct, while for leisure trips changes are the result of indirect effects. This indicates that a residential relocation has a stronger effect on travel choices for leisure trips compared to commute trips, possibly because job locations are mostly located outside the residential neighborhood, while people often perform leisure activities within the residential neighbourhood. For public transport and cycling the study did not find significant effects of changes in neighborhood on changes in how people commute. In all cases using public transport and active travel more frequently significantly improves attitudes towards that particular mode of transport.

Ministry of Transport studies show: "that the specific energy demand per person due to transportation reduces with increasing urban density, as the land area required for a given population decreases and therefore the expected overall travel distance should also become less with increasing density. Higher densities also make public transportation systems more viable. Earlier studies provide some evidence for this relationship between higher urban density and reduced specific energy demand for transportation".[21]

New Zealand Transport Authority (NZTA) research indicates that rather than density being the key determinant residents of a community are more likely to choose to use environmentally

17 The Impact of Urban Form on U.S. Residential Energy Use [2008] Reid Ewing University of Maryland, College Park Fang Rong Milken Institute

18 Ministry of Business, Innovation and Employment (MBIE): Transforming Operational Efficiency ISBN: 978-1-99-001946-3 (online) [2020]

19 Ministry of Transport NZ Household Travel Survey Data 2015-2017

20 De Vos, J., Cheng, L. & Witlox, F. Do changes in the residential location lead to changes in travel attitudes? A structural equation modeling approach. Transportation 48, 2011–2034 (2021). https://doi.org/10.1007/s11116-020-10119-7

21 (Brownstone and Golob, 2009; Ewing and Cervero, 2010; Nichols and Kockelman, 2014)

sustainable modes of transport, such as walking and cycling, when the environment is safe and easy to access. Infrastructure that makes walking and cycling safer is therefore likely to be the most effective intervention for encouraging active transport.[22]

The success of public transport systems is based on numerous factors including its accessibility, how cost is distributed (either by setting fares, public subsidies or a mixture of both) and frequency of service. These are largely determined by how many people can access destinations they wish to reach through the system in a timely fashion and the relative cost in terms of money and effort compared to other methods of transport. Increasing the density of the residential population near stops and providing stops at destinations such as jobs, leisure activities and/or important facilities such as hospitals or schools will increase use of a public transport system leading to improvements in cost and frequency.[23]

Transport modelling carried out by PNCC indicates that increasing density in the city center will increase walking and cycling (by reducing travel distance) and have little impact on public transport. Increasing density further from the center but focused on proximity to bus stops will increase public transport use but have limited impact on walking and cycling. Expanding into new greenfield, even with the provision of new bus stops has little impact on active or public transport.[24]

The addition of bicycle storage options, electric vehicle (including e-bike) charging infrastructure and flexible input/output electricity metering can also help to promote lower carbon transport choices.

5 How can we increase the resilience of medium density homes to current and future effects of climate change conditions?

5.1 Mitigating increases in intensity of storm events

The primary mechanism for mitigating harm from surface water is to avoid developing areas at high risk of frequent flood events. This has been accounted for in the surface water modelling and resulting zoning decisions detailed in the Stormwater Servicing Assessment report[25]. Frequent, low level rainfall events are best managed by a properly sized and managed surface water infrastructure network including Blue-Green Infrastructure. (Quote from/reference the stormwater technical report).

22 Research Report 669 Transport impacts on wellbeing and liveability (nzta.govt.nz)

23 Human Transit: How clearer thinking about public transit can enrich our communities and our lives: Jarrett Walker (2021)

24 The traffic modelling forecast changes in bus and cycle use compared with the Do Minimum is similar for both PCI Scenarios, a city-wide increase of 0.3% cycle trips and a 1.2% reduction in bus trips. It should, however, be noted that within the extent of the PCI Scenarios, the bus use increases by nearly 2%. The city-wide reduction in bus use results from a reduction in school bus use because of the forecast population growth being closer to schools. See the Transportation Assessment for details.

25 "Based on the status quo scenario, it is recommended that intensification in Awapuni, Highbury, Hokowhitu and Takaro is not undertaken as a permitted activity without further detailed analysis as part of a resource consent application"

Increasing the density of housing has the potential to increase the area of impermeable surfaces within a site and cumulatively across the city. This will result in increased pressure on stormwater infrastructure and potentially localised flooding, especially during infrequent intense rainstorms.

Capture and overflow designs to alleviate and direct peak stormwater flows into designated detention areas such as Pitt Park and Norton Park wetlands in Roslyn can help contain water from rainstorms in the short term and allow it to drain away at a manageable rate. These areas are multi-use providing amenity value during dry periods and only flooding infrequently. The scale of detention required will vary depending on the area of hard standing it services but can be at a site, development or suburb scale.

Development also contributes to increases in contaminants in surface water generated by both the construction works and the ongoing activities and transport movements due to increased residential and commercial activity.

Vegetation is the most commonly used way to clean and/or retain stormwater. Specifying vegetation as a buffer between areas of hard standing and stormwater inlets or diverting stormwater to an area of vegetation prior to entering a stormwater inlet can provide multiple benefits. Where vegetation is not practical or desirable, detention can include engineered solutions such as permeable paving, gravel soak-away pits or rainwater detention tanks.

N.B. A distinction is required between stormwater tanks designed to alleviate rainstorm events (which are intended to be empty when needed) and rainwater tanks to collect water for later use (which are intended to be full when needed).

5.2 Mitigating cumulative increases in surface temperature

Provision H1.3.3 of the Building Code states that:

> *Account must be taken of physical conditions likely to affect energy performance of buildings, including—*
>
> *(a) the thermal mass of building elements; and*
>
> *(b) the building orientation and shape; and*
>
> *(c) the airtightness of the building envelope; and*
>
> *(d) the heat gains from services, processes and occupants; and*
>
> *(e) the local climate; and*
>
> *(f) heat gains from solar radiation.*

The heat retention of claddings and hard surfaces varies considerably between materials and is further influenced by shading, orientation, colour (including reflective surface treatments) and the proximity of other materials. It is therefore difficult to specify a single solution to potential cumulative 'Heat Island' effects, but a variety of mitigation options are available to reduce this problem.

The addition of air conditioning to a development will increase air temperature adjacent to the outlet for these systems. Careful placement of air conditioning vents to prevent exacerbating existing issues by avoiding heat-dense north facing claddings or heavily trafficked areas would help reduce this risk.

Vegetation has several benefits in cooling surrounding air, increasing shade and providing co-benefits for amenity, biodiversity and health. Notably, shade from vegetation on or near north-facing walls and on roofs can reduce the cumulative impacts of hot weather[26]. Where vegetation is not practical or desirable shading by louvres, window placement and the inclusion of awnings or overhangs can help reduce internal and external building temperatures.

6 Other potential costs and benefits

6.1 Financial incentives/dis-incentives:

Up-front capital expenditure on planning and designing climate-resilient buildings varies widely will be approximately 2-6% higher than building to the minimum legal standard[27]. These costs could be offset over the lifetime of the buildings by reduced energy costs, reduced risk from climate related issues and improved quality of life for occupants.

New Zealand specific data is limited, however, a study in Australia[28] found that compared with a standard three-star property, those with five or six-star NatHERS ratings[29] attracted premiums of 2.0% and 2.4% respectively. Homes with a seven-star NatHERS rating commanded a premium of 9.4% over their three-star equivalents. This study is based in an area with mandatory energy-efficiency ratings on all buildings at point of sale or lease which drives some consumer behaviors.

Given the relative novelty of sustainable buildings an issue exists in for-profit construction in that, despite the evidence from overseas, a developer cannot be guaranteed to recoup additional up-front costs in the sale price of the building under the current system and therefore there is financial risk in delivering to a higher environmental standard than is required by the building code. This issue applies to all housing but is particularly acute at higher densities where there is already a perception amongst developers that new rules and requirements will cause problems and increase costs.

Any additional sustainability requirements placed on new medium density developments will need to take account of the potential impact on sale price and financial return. One option for mitigating this risk would be mandatory energy efficiency ratings, as demonstrated in Australia, although this may be outside the scope of this plan change.

26 Impacts of Tree and Building Shades on the Urban Heat Island, Park et.al 2021

27 Value Case for Sustainable Building in New Zealand, Ministry for the Environment, 2005

28 Fuerst, Franz & Warren-Myers, Georgia. (2017). Green Lemons? Energy-Efficiency Disclosure and House Prices.

29 Nationwide House Energy Rating Scheme

6.2 Environmental resilience:

Without mitigation the effect of increases in hard surfaces will lead to increases in stormwater volume and a reduction in water quality due to contaminants. This will lead to water quality impacts on watercourses including streams and rivers leading to follow on impacts on biodiversity along the river corridors.

Increasing density will reduce the impacts from development on greenfield sites by making more efficient use of existing land. However, given that most available land near Palmerston North is currently under pastoral production there is unlikely to be substantial amenity, biodiversity or carbon sequestration value lost.

Mitigation for urban heating, in particular the intentional use of vegetation, will provide co-benefits in terms of reduced physical and mental health impacts for residents[30] and opportunities for urban wildlife. This can be further supported by the selection of native plant species with biodiversity benefits.

6.3 Economic benefits:

Dense mixed-use developments have the potential to collectivise costs for otherwise prohibitively expensive services. This could be technologies such as battery storage for rooftop solar systems and on-site water filtration or services such as pool cleaning and maintaining communal spaces.

Some developments will create opportunities for new businesses that provide services to local residents such as daytime hospitality, early years education and healthcare.

6.4 Risks of acting or not acting

Insufficient rigor and urgency in mitigating climate emissions risks increasing the severity of climate impacts resulting in greater harms, costs and risks in the long term.

Not planning and adapting sufficiently to climate change risks increases the likelihood of fatalities or public health harms (e.g. through flooding, heat stress, etc.), infrastructure damage and increased costs.

Failure to increase density within the city will, due to the required increase in housing provision, lead to continued residential development at the edge of the city. These single unit developments will lead to a relative increase in carbon emissions from materials, operation and disposal compared to mixed use.

International evidence indicates that the denser building typologies proposed in this plan change result in lower embedded and operational carbon emissions and are likely to result in a net reduction in terms of overall greenhouse gas emissions compared to single detached dwellings. Given this conclusion it may be that no additional restrictions or obligations are

30 Do greenspaces really reduce heat health impacts? Evidence for different vegetation types and distance-based greenspace exposure; Jinglu Song, Antonio Gasparrini, Di Wei, Yi Lu, Kejia Hu, Thomas B. Fischer, Mark Nieuwenhuijsen.

required for medium-density development to be considered a net benefit in relation to climate change.

Failure to increase density within the city will result in longer vehicle trips from new housing to the same destinations, incentives away from active and public transport and as a result increases in transport related carbon emissions.

The presence of development close to public amenities and active or public transport networks will provide a net benefit in terms of reducing carbon emissions from transport. This will need to be offset against improvements in the availability and utility of public transport networks and improvements in active mode infrastructure (e.g. cycle lanes and footpaths) to meet the increased demand.

Single unit developments in greenfield locations create issues for stormwater infrastructure by increasing impermeable surfaces without providing sufficient justification for network upgrades or on-site detention, resulting in cumulative impacts on existing stormwater infrastructure.

Increased density allows opportunities for collectivised infrastructure such as rainwater detention that will help to slow the transmission of rainwater into the public stormwater network. The inclusion of this private infrastructure in the network raises issues of capacity maintenance, with the ongoing availability and capacity of privately held detention systems being subject to highly variable and often opaque maintenance regimes. A risk exists that reliance on privately maintained stormwater detention may result in failures during infrequent rainstorm events.

Failure to plan for and reduce the Urban Heat Island Effect will result in increased risk to public health and increased maintenance costs for infrastructure that will be difficult or expensive to remedy through repairs and upgrades, compared to designing in features during construction.

Increased density allows opportunities for collectivised infrastructure such as open space shaded by trees that will help to reduce cumulative heating and provide opportunities for physical and psychological relief during extended hot periods.

Not leveraging and including nature-based solutions to issues such as shading and on-site water retention could increase the risk of water scarcity during summers. Engineered solutions to these issues would be expensive to retrofit and would increase maintenance costs for developments.

7 Recommendation - preferred approach

7.1 Moderating Greenhouse Gas Emissions

The construction of medium-density residential units is likely to result in localised emission savings compared to equivalent single story residential units. Given their inclusion in the NZ Emissions Trading Scheme, these net emission reductions should not be expected without changes to the scheme, but the costs for occupants of compliance with the scheme will be reduced relative to the counterfactual.

Recommendations to support lower emissions, where practical, include:

- Orienting rooves to allow for optimal solar gain, after allowing for the constraints of a particular site.
- Encouraging the designing of north-facing windows to allow maximal solar gain during low sun conditions in winter whilst minimising solar gain during high sun conditions in summer.
- Encourage the provision of secure bicycle (including e-bike) storage on site.
- Encourage the provision of electric vehicle charging (or enabling infrastructure) on site.

7.2 Climate Change Resilience

Stormwater issues relating to rainfall intensity and river volumes will worsen over the next 50 years due to climate change. The primary mechanism for mitigating harms from stormwater is avoidance, and any new residential development should avoid areas currently at risk of regular flooding or erosion and avoid areas that will become at risk due to projected changes in rainfall patterns in the future. Where this is not possible or desirable then on-site mitigation to reduce the potential for harm should be required.

Recommendations to support resilience to high intensity rainfall events include:

- The latest climate projections should be used in considering flood and erosion risk and stormwater management requirements.
- Developments, where practical, should maximise permeable space to reduce stormwater runoff volumes, and support soil health and hydrological processes.
- Developments, where practical, should include trees, natural vegetation, or other shading elements to reduce the impact of the urban heat island effect and the broader impact of climatic warming.

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