# Are we building harder, hotter cities?

## The vital importance of urban green spaces

**March 2023**

Parliamentary Commissioner for the Environment
Te Kaitiaki Taiao a Te Whare Pāremata

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# Contents

*Leptopteris hymenophylloides*

# Overview

The genesis of this report is rooted in the profound changes that Aotearoa New Zealand's cities are undergoing. Successful cities are frequently celebrated as dynamic, living organisms in which people and capital unleash a constant process of creative destruction – or as a friend once put it more prosaically: cities are where ideas go to have sex. Ceaseless change is the best evidence that life in the city is well.

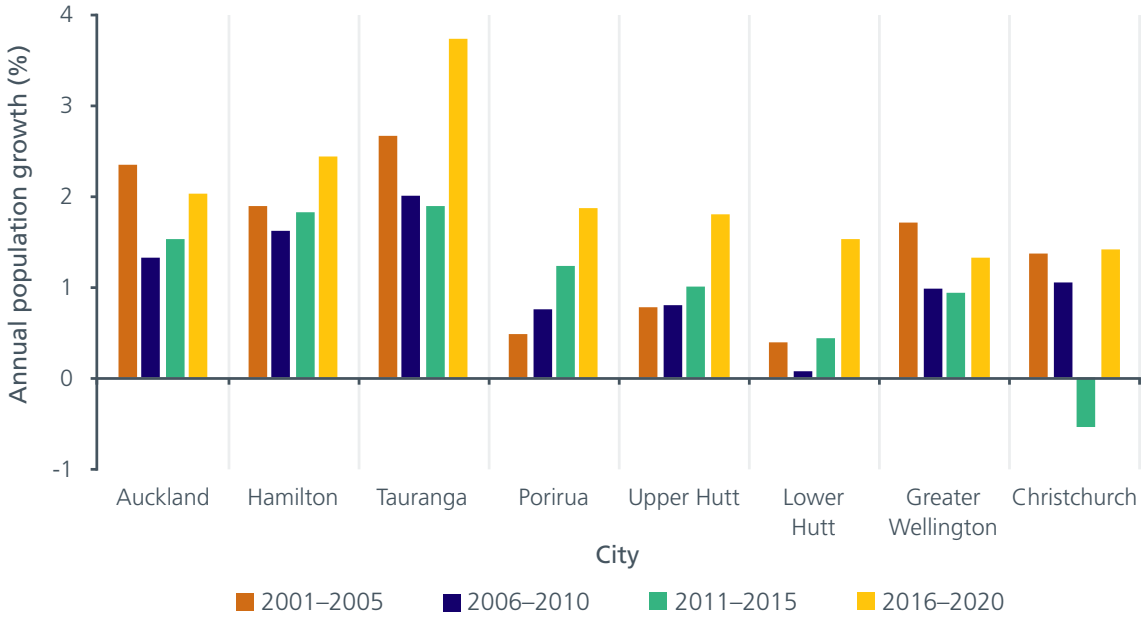
Strong population growth and rising consumption in our major cities demanded change. To freeze the frame of urban form would be to strangle that dynamic. But what sort of form should accommodate all that dynamism? We are all familiar with the debate over sprawl versus densification. For decades people have frowned at the loss of highly productive land. More recently climate change has added to those concerns. Sprawling, low density cities are energivores. Traffic congestion has become a symbol of urban dysfunction. Travel times have become as frequent a topic of conversation in Auckland as the weather.

The response has been a slew of changes designed to accommodate many more people within the footprint of our existing cities and to radically change the texture of greenfield extensions. Massive hard infrastructure projects for transport and water have been initiated. In the process, the importance of green space risks being overlooked or even ignored.

This is a report about what those changes driven by growth and intensification may mean for the share of urban space that might be described as 'green' and the environmental services they provide.

## How our cities are growing

Recent years have seen a significant increase in the rate of population growth in New Zealand's cities (Figure O.1). On average, Auckland's population grew by almost 30,000 people a year between 2016 and 2020. The combined population of Hamilton, Tauranga, Greater Wellington and Christchurch grew by almost 20,000 people annually during the same period. Our cities have struggled to keep up, with demand for housing and the infrastructure required to support it outstripping supply.

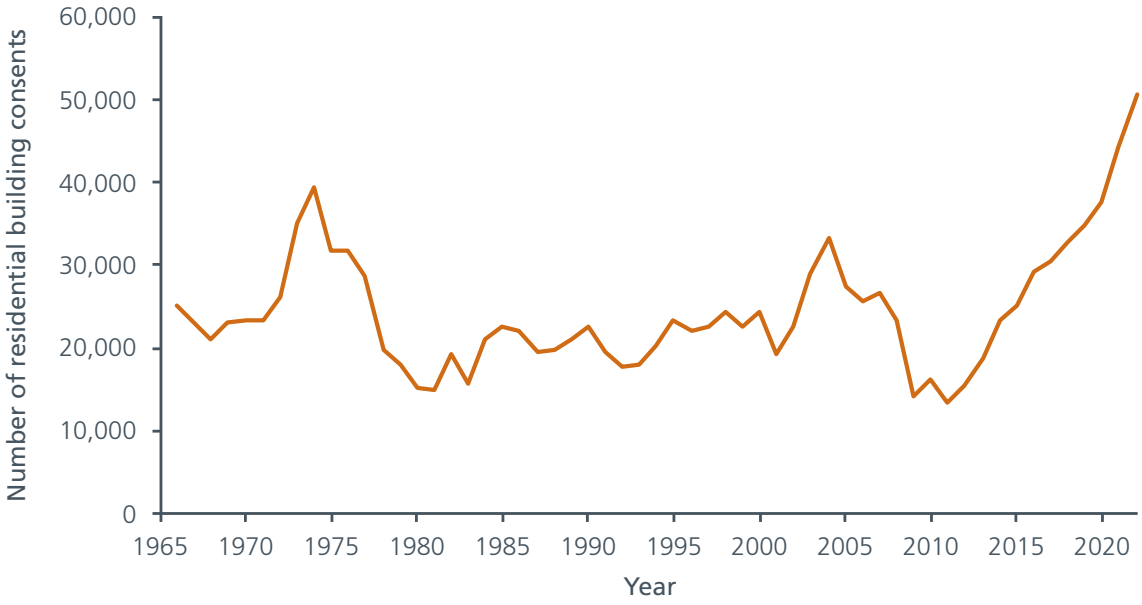



Source: Data from Stats NZ (2022b)

**Figure O.1: Rate of population growth in selected New Zealand cities, 2001–2020.**

Market dynamics together with ongoing efforts from central government mean that a significant uptick in housing construction is now underway. In the year ended June 2022, consent was granted for 50,736 new dwellings across New Zealand – more than at any time since records began in 1966 (Figure O.2).[1] Most of these additional homes are being built in cities.

[1] Although not in per-capita terms. In 1973, 35,000 new dwellings were consented in New Zealand – around 11 for every 1,000 residents. In 2021, the equivalent figure was 9 consented dwellings per 1,000 residents.




Source: Data from Stats NZ (2022a)

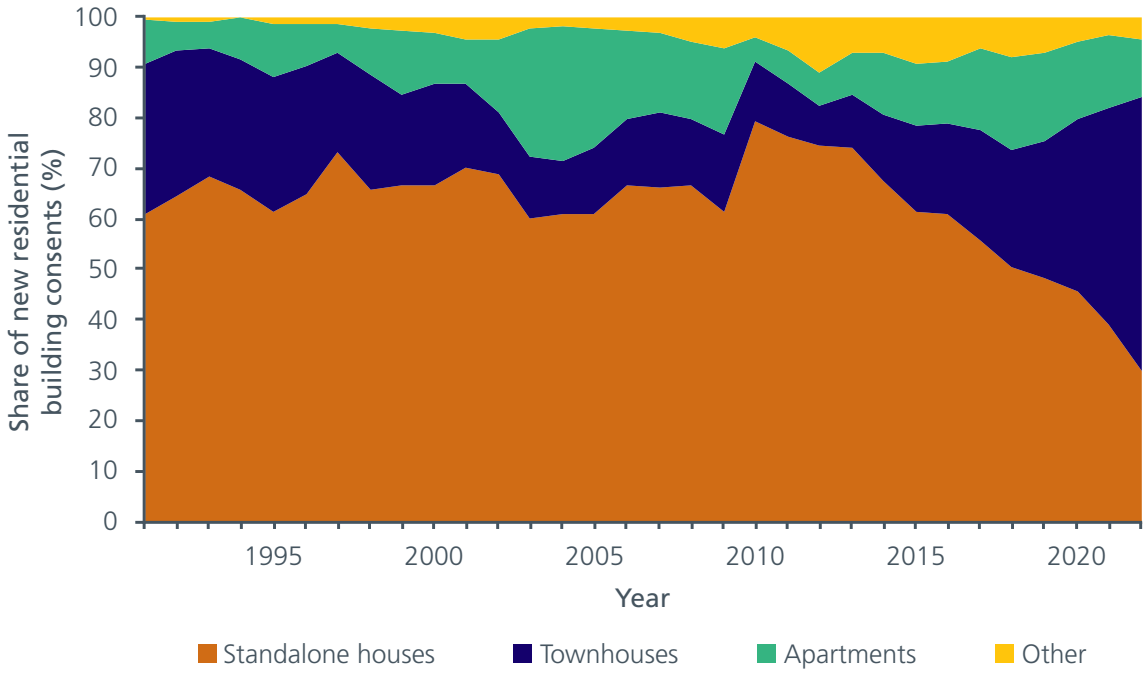
**Figure O.2: Residential construction trends in New Zealand, 1966–2022.**

The urban form that is emerging from this activity diverges from the past. In contrast to the creation of standalone homes in new peri-urban suburbs, much of the housing currently being built is in the form of attached or semi-attached homes (e.g. townhouses, duplexes, terraced houses) in existing suburbs.[2] This investigation set out to quantify the extent of green space in three major cities and how it has changed over time, using novel techniques to interrogate aerial photographs. The analysis extends to three cities (Auckland, Hamilton and Greater Wellington) for three discrete time periods (1940s, 1980s and today).

The analysis reveals that about 75% of the residential titles created in Greater Wellington since 2016 are within the pre-existing urban footprint. The equivalent figures in Auckland and Hamilton are approximately 70% and 60%, respectively. Some of that activity involves the comprehensive redevelopment of existing suburbs; Kāinga Ora – Homes and Communities' urban regeneration projects in Mount Roskill and Māngere, for example. But the majority involves smaller-scale two- or three-lot subdivisions of pre-existing residential sections. This has obvious implications for the amount of open space, green or otherwise.

[2] The term 'medium-density housing' is widely used to refer to these (and related) dwelling types. That said, there is no single definition of medium-density housing. According to BRANZ (2022), it excludes standalone houses but extends all the way to apartment buildings up to six storeys high. In contrast, a developer spoken to during this investigation felt that, at a minimum, medium-density housing requires a shared entranceway and collective car parking – a definition that largely excludes townhouses, duplexes and terraced housing.

Building consent data provide additional insights. The share of townhouses, units and flats in all new residential builds in New Zealand cities increased from about 10% in 2011 to about 55% in 2022 (Figure O.3).[3,4] During the same period, the share of apartments being built remained roughly constant at around 10%, while the share of standalone houses decreased from approximately 75% to approximately 30%.




Source: Data from Stats NZ (2022a)

**Figure O.3: Changing patterns of residential development in Auckland, Hamilton, Tauranga, Greater Wellington and Christchurch.**

These development trends predate the implementation of two recent central government policy initiatives designed to encourage additional housing supply through intensification in Tier 1 urban environments.[5] One, the National Policy Statement on Urban Development (NPS-UD), will provide additional impetus for development 'upwards' in areas close to existing centres and public transport nodes. The other, the Medium Density Residential Standards (MDRS), will allow development 'inwards' across significant swathes of the urban area. At the same time, the National Policy Statement for Highly Productive Land and the wetlands provisions in the National Policy Statement for Freshwater Management will further support housing intensification over development outwards.

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[3] Stats NZ building consent data distinguishes between four dwelling types: standalone houses; townhouses, flats, units and other dwellings; apartments; and retirement homes.

[4] That is not just an Auckland phenomenon. In Hamilton, townhouses and units as a proportion of all new residential builds increased from ~10% to ~65% during the same period. In Christchurch, the equivalent figures were ~20% and ~55%.

[5] Tier 1 urban environments are those in Auckland (Auckland Council), Tauranga (Tauranga City Council, Western Bay of Plenty District Council), Hamilton (Hamilton City Council, Waikato District Council, Waipā District Council), Wellington (Wellington City Council, Porirua City Council, Hutt City Council, Upper Hutt City Council, Kāpiti Coast District Council), and Christchurch (Christchurch City Council, Selwyn District Council, Waimakariri District Council) (Te Tūāpapa Kura Kāinga, 2022).

The ongoing shift towards urban intensification will almost certainly help to address some of the environmental challenges posed by cities – transport emissions and vehicle congestion being chief among them. While the magnitude of that impact will depend significantly on (i) where within the city intensification occurs and (ii) various external factors,[6,7] there is an extensive body of research showing that vehicle kilometres travelled are lower in denser, more compact cities.[8] Cities that sprawl less may also reduce pressure on productive soils close to the urban fringe.

But ongoing urban intensification also comes with risks for the amount and functionality of urban green space. Infill development often results in the removal of soil and vegetation from private yards and sections. At the same time, associated increases in population density can increase pressure on nearby public parks and reserves.

Those risks received some attention during the development of the NPS-UD and the MDRS. For example, the MDRS require that a minimum of 20% of a development site be retained as landscaped area. And both policies identify public open space as a qualifying matter, meaning that councils can choose to exclude it from up-zoning and development.

Nevertheless, more could be done. While both the NPS-UD and MDRS identify accessibility to natural spaces and open spaces as a key element of "well-functioning urban environments",[9] neither provides any guidance, tools or additional funding sources to help councils achieve that. It is telling that the NPS-UD classifies public open space as "additional" infrastructure – something that councils need only be satisfied "is likely to be available".[10] By contrast, when it comes to "development" infrastructure, namely three waters and transport networks, councils are *required* to provide sufficient capacity to meet expected demand for housing and for business land over the short term, medium term and long term.[11]

## Do we really need green space?

Some may ask whether, in the midst of burgeoning demand for housing, the provision and protection of urban green space is really something that warrants attention. After all, every square metre of potentially developable land that is set aside as parks, yards, gardens or lawns cannot be used for housing.

It is important to respond to that question because the changes we are making to the shape and form of our cities are largely irreversible. If they are not executed skilfully, we risk building less liveable environments that we will have to live with forever. There are at least three particular concerns.

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[6] A recent Organisation for Economic Co-operation and Development (OECD) modelling assessment undertaken for Auckland found that intensification focused around existing employment hubs and transport corridors produced larger transport emissions reductions than intensification more generally (OECD, 2020, p.116).

[7] For example, preferences over working from home, the future of online shopping and the quantum of investment in public transport networks.

[8] The Intergovernmental Panel on Climate Change (IPCC) recently concluded that "multiple lines of evidence reaffirm the key findings from AR5, especially regarding the mitigation benefits associated with reducing vehicle miles or kilometres travelled (VMT/VKT) through spatial planning" … "Modifying the layout of emerging urbanization to be more compact, walkable, and co-located can reduce future urban energy use by 20–25% in 2050 while providing a corresponding mitigation potential of 23–26%" (IPCC, 2021 – AR6, chapter 8).

[9] NPS-UD, policy 2.2; Resource Management Act 1991, schedule 3A, policy 3.

[10] NPS-UD, clause 3.5.

[11] NPS-UD, clause 3.2.

The first is what the loss of green space might mean for the health and wellbeing of city dwellers. Cities are frenetic, busy and often noisy places to live. Having places nearby to exercise or socialise, or simply to escape the day-to-day clamour of city life, plays a vital role in promoting good mental and physical health. The importance of urban green space was highlighted during recent Covid-19 lockdowns when movement restrictions meant access to nearby parks and reserves became a lifeline for many people.

The second concern relates to the environmental services that green space provides. If we had forgotten the value of these services, recent extreme weather events have put them right back at the centre of everyone's attention. In the 18 months it has taken to prepare this report a series of major storm events have left destruction in their wake across New Zealand. Daily and monthly rainfall records have been swept away in, for example, Nelson and Auckland.[12] Ageing stormwater systems have been overwhelmed, flooding houses and businesses and leaving their owners with costly clean ups.[13]

These events have demonstrated the perils of creating large, hardened and impermeable surfaces that simply cannot cope with the sort of precipitation a warmer atmosphere is delivering.[14] One response might be simply to harden up further – even more gigantic stormwater management structures and stouter defences of steep ground and coastal margins. But even if that worked, climate change is bringing temperature stress in its wake. Heat wave crises have not yet been acutely felt in New Zealand, but there is every reason to believe they will be – and when they are, a cityscape of concrete, asphalt and black roofs will serve only to amplify the discomfort of city dwellers and, in some cases, put lives at risk.

It is an irony that in an age of rising environmental concern, more people live in urban settings cut off from the natural environment than ever before. But urban dwellers are as dependent on the environment as they ever were. Green spaces continue to provide a range of vital services, including temperature regulation, stormwater management, air filtration, carbon sequestration and habitat provision.

The third concern relates to the amenity or 'placemaking' benefits that urban green space provides. While visual amenity means different things to different people, the value proposition around denser urban living is generally considered to be improved by the presence of trees and vegetation.

The value of these services – recreational, environmental and visual – is not constant in time. Looking forward, the ongoing shift towards more densely populated cities and the emerging impacts of climate change will very likely make urban parks, reserves, gardens, vegetation and street trees more valuable. The difficulty of re-establishing green space once lost should cause us to think very carefully about hasty development decisions that future generations may live to regret.

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[12] MetService, 2022; NIWA, 2023. For example, up to 280 mm of rain fell in Auckland in 24 hours on Friday 27 January 2023, causing significant flooding across the Auckland region. This event was unprecedented in the historical record and was at least a 1-in-200-year event (NIWA, 2023).

[13] Between May 2021 and September 2022 over $650 million in insurance claims were made for loss and damages (Insurance Council of New Zealand, 2023).

[14] For example, rainfall in Canterbury in May 2021 was 10–15% more intense due to human influence on the climate system. Similar (5–10%) increases in rainfall intensity were calculated for the storm that brought flooding to Buller in July 2021 (Stone et al., 2022).

I find myself increasingly irritated by the scores of documents that emerge from central and local government talking tritely about 'quality urban environments' in which people can 'live, work and play'. These soothing green noises are too often offered as a substitute for hard analysis. A determination to increase housing supply through denser, infill housing within the pre-existing boundaries of cities involves a necessary trade-off with the amount of private urban green space that will remain. The extent of that trade-off should be explicit and open to debate.



This report does not seek to judge what the extent of that trade-off should be. Neither does it spend a lot of time on cultural, health and amenity values. While important, these are widely commented on. The focus, rather, is on the underlying environmental services that are too often taken for granted. I hope that this report will improve our understanding of how and where green space is changing, for what reasons, and what the likely consequences of those changes might be. Importantly, it looks at the totality of green space, public and private, and attempts to signal the environmental services and values that need to be monitored and provided for as urban form and density evolve.

Source: Google Maps

**Figure O.4: Recent years have seen a shift away from standalone housing in our cities, with townhouses/duplexes (top – Rototuna, Hamilton) and terraced housing (middle – Avondale, Auckland) becoming increasing popular. The market share of apartments (bottom – Hobsonville, Auckland) has remained relatively constant.**

## A quick guide to this report and its findings

After clearing away definitional issues about green spaces and the services they provide (chapter one), the report presents the results of the empirical analysis commissioned to document the change in green space over time (chapter two).

Chapter three examines the way the current legislative and regulatory system influences the provision and protection of green space in our cities. It outlines the tools and approaches used by councils to set aside new public parks and reserves, as well as those that influence the distribution of privately owned yards, gardens and trees.

More challengingly, chapter four looks to the future. It assesses how the availability – and value – of urban green space might evolve in response to two long-run trends: urban intensification and climate change. The discussion concludes that green space is likely to be in reduced supply (and under increased strain) at precisely the time the services it provides are needed most. This raises important questions for those responsible for determining the shape of urban development today.

I am advancing a number of proposals designed to ensure that the contribution green space can make to urban environments is fully accounted for in future urban design rather than marginalised as a decorative (and shrinking) veneer. These are detailed in chapter five and include:

- Ensuring that the full range of services provided by green spaces, and the extent to which these could be compromised by urban development, is explicitly assessed by councils so that trade-offs are made on an informed basis.
- Monitoring and measuring the extent of green space in a consistent way.
- Encouraging councils and relevant government agencies to take actions to improve the quality and/or quantity of green space in suburbs where it is in decline or in otherwise short supply.
- Reviewing the way green space is reconfigured in the wake of inner-city development and intensification, and the way new green space is set aside in greenfield developments.

**Simon Upton**

**Parliamentary Commissioner for the Environment**

*Sticherus urceolatus*

# Tirohanga whānui

Ko te pūtake o te tīmatanga o tēnei pūrongo ko ngā panonitanga hōhonu o ngā tāonenui o Aotearoa. He auau te whakanui i ngā tāonenui hei rauropi hihiri, e ora ana  e tukuna ai te hātepe riterite o te whakamōtī auaha – pēnei rānei i te kōrero wana-kore a taku hoa: ko ngā tāonenui ngā wāhi e haere ai ngā whakaaro ki te onioni. Ko te panoni mutunga kore te tino taunakitanga e tino ora ana te noho ki te tāonenui.

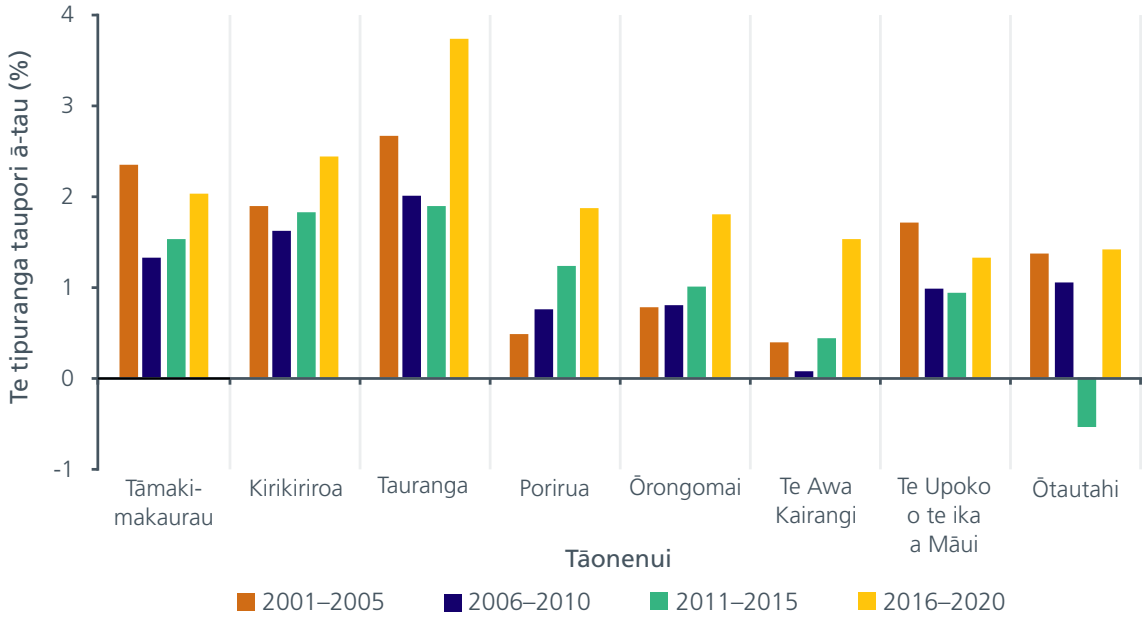
Ka whakahau panoni te tipu kaha o te taupori me te pikinga o te whakapeto i roto i ō tātou tāonenui matua. Ki te whakatoka i te anga o te āhua tāone, ka natia taua hihiritanga. Engari me pēhea te āhua hei tiaki i taua hihiritanga? E mōhio ana tātou katoa ki te taupatupatu mō te mahora ki te apiapi. Kua hōhā ngā tāngata ki te ngaromanga o te whenua tino māpua mō ngā tekau tau maha. Inakuanei kua tāpirihia te panoni āhuarangi ki aua āwangawanga. Ko ngā tāonenui mahora, apiapi iti e kai ana i te ngao. Ko te tūkati waka tētahi tohu o te turingonge tāone. Kua ōrite te kōrero mō te roa o te hāereere i Tāmakimakaurau ki tērā mō te huarere.

Ko te urupare he panoni maha e hoahoatia ana ki te āwhina i te maha noa atu o te tangata i roto i te tapuwae o ō tātou tāonenui onāianei me te whakarerekē rawa i te kakano o ngā torohanga whīra kākāriki. Kua tīmata ngā hinonga hanganga mō te ikiiki me te wai. I roto i te hātepe nei, he nui te tūraru kāore e kitea, ka whakangongotia rānei te hiranga o te takiwā kākāriki.

He pūrongo tēnei e pā ana ki te tikanga o aua panoni e ākina ana e te tipuranga me te apiapi mō te tuari o te takiwā tāone e kīia ana he 'kākāriki' me ngā ratonga taiao e whakaratohia ana e taua takiwā tāone.

## He pēhea te tipu o ō tātou tāonenui

Inakuanei kua kitea te pikinga nui i te pāpātanga o te tipuranga taupori i ngā tāonenui o Aotearoa (Hoahoa O.1). E ai ki te toharite, e tata ana ki te 30,000 te tipu o te taupori o Tāmakimakaurau i ia tau i waenganui i te 2016 me te 2020. Hui katoa i tipu te taupori o Kirikiriroa, Tauranga, Te Whanganui-a-Tara whānui me Ōtautahi mā te 20,000 tāngata i ia tau i roto i taua wā tonu. He uaua mā ō tātou tāonenui te whakatutuki i te tono mō te wharenoho, ā, he nui ake te hanganga e hiahiatia ana kia tautoko ai i tērā e whakaratohia ana.

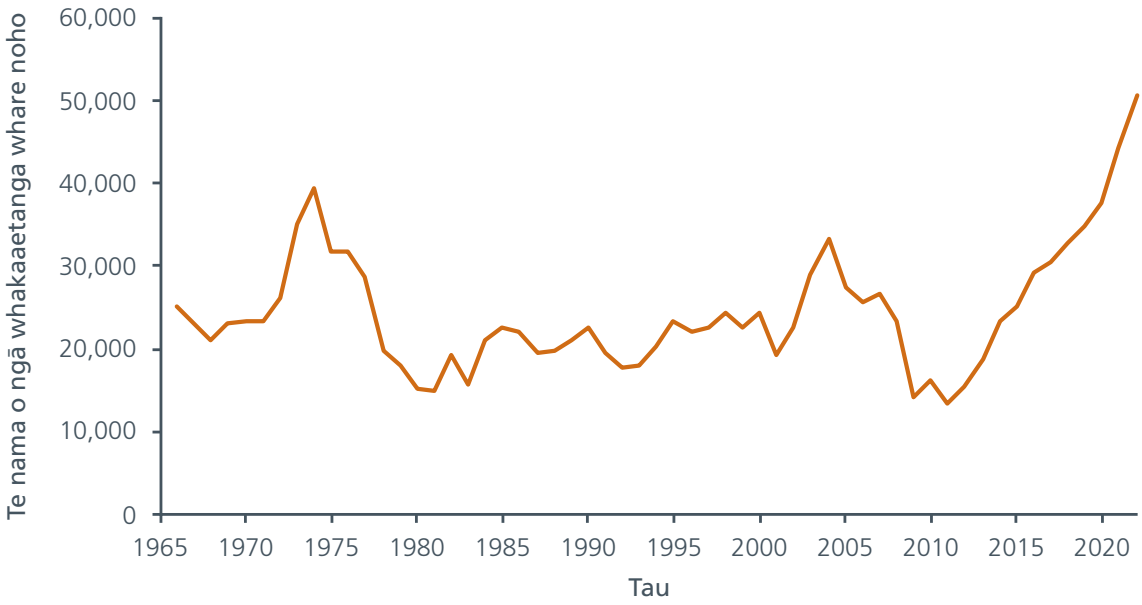



Mātāpuna: Nō Tatauranga Aotearoa te raraunga, 2022b

**Hoahoa O.1: Te pāpātanga o te tipuranga taupori i roto i ngā tāonenui o Aotearoa kua kōwhiria: 2001–2020.**

Ko te tikanga o ngā hihiringa o te mākete me te whakapau kaha a te kāwanatanga matua tērā tētahi pikinga nui o te hanga wharenoho ināianei. I te tau i oti i te Hune 2022, i tukuna te whakaaetanga mō ngā whare hou e 50,736 puta noa i Aotearoa – he nui atu i tētahi atu wā mai i te tīmatanga o ngā mauhanga i te tau 1966 (Hoahoa O.2).[1] E hangaia ana te nuinga o ēnei kāinga tāpiri i roto i ngā tāonenui.

[1] Engari kāore i pērā mō ia kotahi rau. I te tau 1973, i whakaaetia ngā whare hou e 35,000 – ko tōnā 11 mō ia kotahi mano kainoho. I te tau 2021, ko te nama ōrite ko te 9 whare noho e whakaaetia ana mō ia kotahi mano kainoho.




Mātāpuna: Nō Tatauranga Aotearoa te raraunga, 2022a

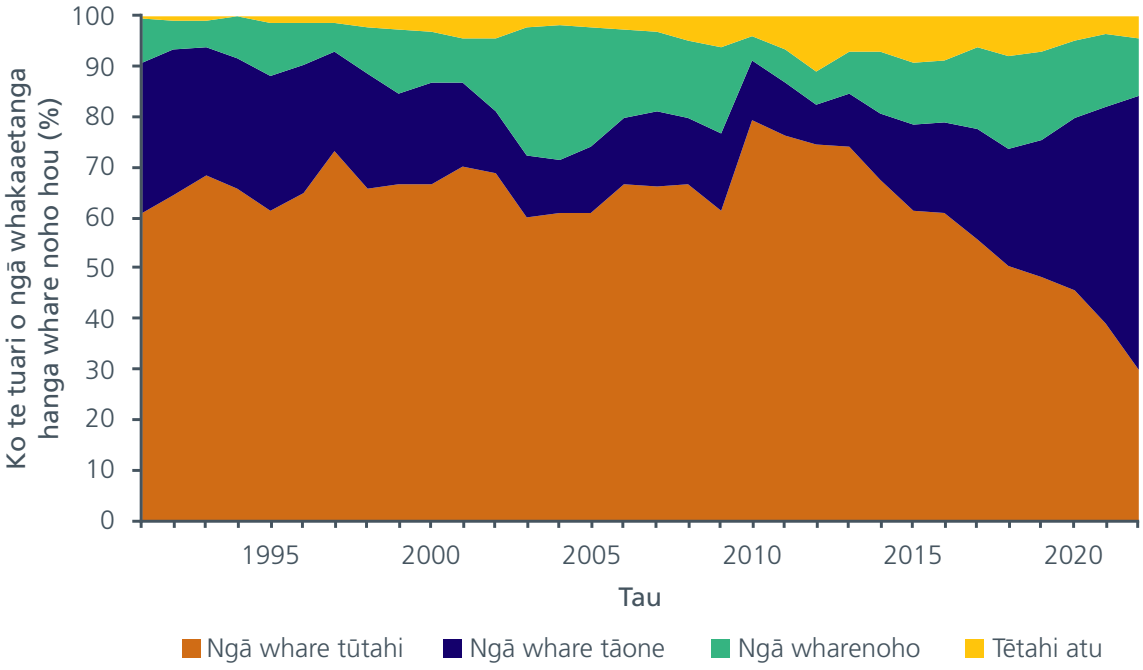
**Hoahoa O.2: Ko ngā ia hanga whare noho i Aotearoa: 1966–2022.**

Ka rerekē haere te āhua tāone e puta mai ana i tēnei mahi i tō te wā i mua. Hei whakatauaro ki te auahatanga o ngā whare tūtahi i roto i ngā paenoho tata tāone, ko te nuinga o ngā whare noho e hangaia ana ināianei ko ngā kāinga tūhono, āhua tūhono rānei (hei tauira, ko ngā whare tāone, ngā whare tuarua, ngā whare parehua rānei) i roto i ngā paenoho onāianei.[2] Ka whakarite tēnei whakatewhatewha ki te tatau i te whānuitanga o te takiwā kākāriki i roto i ngā tāonenui matua e toru, ā, he pēhea te panoni i te hipatanga o te wā, mā ngā nuka hou e uiui ngā whakaahua wakarererangi. Ka pā atu te tātaritanga ki ngā tāonenui e toru (Tāmakimakaurau, Kirikiriroa me te Whanganui-a-Tara whānui) mō ngā wā rerekē e toru (ngā 1940, ngā 1980 me tēnei wā tonu).

E whakaatu ana te tātaritanga ko tōna 75 ōrau o ngā taitara wharenoho e auahatia ana mai i te tau 2016 i roto i te Whanganui-a-Tara whānui e noho ana i roto i te tapuwae tāone onāianei. Ko ngā nama ōrite i Tāmakimakaurau me Kirikiriroa e tata ana ki te 70 ōrau me te 60 ōrau. Ko ētahi o aua mahi e pā ana ki te tino whakawhanaketanga anō o ngā paenoho onāianei – ko ngā hinonga whakahou tāone a Kāinga Ora i Mount Roskill me Māngere hei tauira. Engari ko te nuinga he rahi iti iho o ngā wawaetanga wāhanga rua, toru rānei o ngā tekihana wharenoho onāianei. He ngāwari te kite i te putanga mō te nuinga o te takiwā tuwhera, ahakoa kākāriki, aha rānei.

[2] He whānui te whakamahi o te kupu 'whare noho apiapi waenga' ina kōrero ana mō ēnei tūmomo whare noho (me ngā mea āhua ōrite). Ahakoa tērā, kāore he whakamāramatanga kotahi o te whare noho apiapi waenga. E ai ki BRANZ (2022), ka awerehia ngā whare tūtahi, engari ka tae atu ki ngā wharenoho teitei tae atu ki ngā papa e ono. Hei whakatauarotanga, e ai ki tētahi kaiwhakawhanake i kōrerohia i roto i tēnei whakatewhatewha, kia eke ki te wharenoho apiapi waenga me whai i te urunga tuari me te pāka ōrite - he whakamāramatanga e awere ana i te nuinga o ngā whare tāone, ngā whare tuarua me te whare parehua.

E whakarato ana ngā raraunga whakaaetanga hanga whare i ngā whakamāramatanga anō. Ko te tuari o ngā whare tāone, ngā whare wāhanga me ngā whare papatahi i roto i ngā hanga whare noho hou i piki i ngā tāonenui o Aotearoa mai i te 10 ōrau i te tau 2011 ki te 55 ōrau i te tau 2022 (Hoahoa O.3).[3,4] I roto i taua wā tonu, he āhua ōrite te tuari o ngā wharenoho i te 10 ōrau, engari i heke te tuari o ngā whare tūtahi mai i tōna 75 ōrau ki tōna 30 ōrau.




Mātāpuna: Nō Tatauranga Aotearoa te raraunga, 2022a

**Hoahoa O.3: Ko ngā panonitanga o ngā tauira o te whanaketanga whare noho i Tāmakimakaurau, Kirikiriroa, Tauranga, Te Whanganui-a-Tara whānui me Ōtautahi.**

[3] Ka whakarerekē te raraunga whakaae hanga whare a Tatau Aotearoa i ngā tūmomo whare noho e whā: ngā whare tūtahi; ngā whare tāone, ngā whare papatahi, ngā whare wāhanga me ētahi atu whare noho; ngā wharenoho ; me ngā kāinga kaumātua.

[4] Ehara i te mahi i Tāmakimakaurau anake. I Kirikiriroa i piki ngā whare tāone me ngā whare wāhanga hei hautanga o ngā hanga whare noho katoa i te 10 ōrau ki te 65% i taua wā tonu. I Ōtautahi, ko ngā nama ōrite ko te 20 ōrau me te 55 ōrau.

I puta mai ēnei ia whanaketanga i mua i te whakatinanatanga o ngā take kaupapahere kāwanatanga matua hou e rua e hoahoatia ana ki te whakatenatena i te whakaratonga whare noho anō mā te apiapi i roto i ngā taiao tāone Taumata 1.[5] Ko tētahi, ko te Tauākī Kaupapahere ā-Motu mō te Whanaketanga Tāone (NPS-UD), ka whakarato i te akiaki hou mō te whanaketanga 'ki runga' i roto i ngā takiwā e tata ana ki ngā pokapū onāianei me ngā pito ikiiki tūmatanui. Ko tētahi atu, ko ngā Paerewa Wharenoho Apiapi Waenga (MDRS), ka whakaae i te whanaketanga 'ki roto' e kapi ana i ngā wāhi nui o te takiwā tāone. I taua wā tonu, ka tautoko hoki te Tauākī Kaupapa Here ā-Motu mō te Whenua Haumako me ngā wāhanga e pā ana ki te kūkūwai i roto i te Tauākī Kaupapa Here ā-Motu mō te Whakahaere Wai Māori i te apiapi whare noho kaua ko te whanaketanga whakawaho.

Kāore e kore ka āwhina te neke ki te apiapi tāone ki te urupare i ētahi o ngā wero ā-taiao e tukuna ana e ngā tāonenui – ko ngā putanga ikiiki me te tūkati waka ngā mea tino nui. Ahakoa e hāngai ana te nui o te pānga ki (i) hea e whakamahia ana te apiapi i roto i te tāonenui,[6] me (ii) ētahi āhuatanga kē,[7] he maha ngā rangahau e whakaatu ana he iti iho ngā kiromita waka o ngā waka i roto i ngā tāonenui iti rawa, tino apiapi hoki.[8] Ka whakaiti pea ngā tāonenui kāore i te mahora i te pēhanga ki ngā oneone māpua e tata ana ki te taitapa tāone.

Engari he tūraru anō nō te apiapi tāone mō te nui me te whakamahinga o te takiwā kākāriki tāone. I te nuinga o te wā nā te whanaketanga whakakī e tangohia ai te oneone me te otaota i ngā iari me ngā wāhanga tūmataiti. I taua wā tonu, ka whakapiki ngā apiapi taupori hāngai i te pēhanga ki ngā pāka me ngā papa rēhia.

Ka kitea aua tūraru i te tirohanga i te wā o te whanaketanga o te NPS-UD me te MDRS. Hei tauira, ka herea e te MDRS kia kaua e iti iho i te 20 ōrau o te takiwā whanaketanga hei takiwā horanuku. Ka tautuhi ngā kaupapahere e rua i te takiwā tuwhera hei take māraurau, arā, ka taea e ngā kaunihera te awere i te whakaritenga ki runga me te whanaketanga.

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[5] Ko ngā taiao tāone Taumata 1 kei Tāmakimakaurau, Tauranga (Tauranga City Council, Western Bay of Plenty District Council), Kirikiriroa (Hamilton City Council, Waikato me Waipā District Councils), Te Whanganui-a-Tara (Wellington, Porirua, Hutt City me Upper Hutt City Councils, me Kāpiti Coast District Council), me Ōtautahi (Christchurch City Council, Selwyn me Waimakariri District Councils) (Ministry of Housing and Urban Development, 2022).

[6] Tērā tētahi aromatawai whakatauira a te Organisation for Economic Co-operation and Development i whakaritea mō Tāmakimakaurau i kite ko te apiapi e arotahi ana ki ngā pokapū mahi me ngā huarahi ikiiki i whakaputa i ngā whakaitinga nui rawa o ngā putanga ikiiki i tō te apiapi matawhānui (OECD, 2020, wh.116).

[7] Hei tauira ko ngā hiahia kia mahi ki te kāinga, te anamata o te hoko ā-ipurangi me te nui o te whakangao ki ngā whatunga ikiiki tūmatanui.

[8] Inakuanei i whakatau The Intergovernmental Panel on Climate Change , "he nui rawa ngā rārangi taunakitanga e tautoko anō i ngā kitenga matua i te AR5, otirā e pā ana ki ngā painga whakamauru e hāngai ana ki te whakaiti i ngā maero waka, ngā kiromita rānei e haerehia ana (VMT/VKT) otirā mā te whakamahere takiwā. ... Mā te whakarerekē i te takotoranga o te tāone e hangaia ana kia iti, kia āhei te hīkoi, me te takiwā ōrite, ka whakaiti i te whakamahi ngao tāone anamata mā te 20-25 ōrau hei te tau 2050 me te whakarato i te torohū whakamauru hoki o te 23-26 ōrau" (IPCC, 2021, AR6, Upoko 8).

Heoi anō, tērā ētahi mea e taea ana te mahi. Ahakoa ka tautuhi te NPS-UD me te MDRS i te āheitanga ki ngā takiwā māori me ngā takiwā tuwhera hei kaupapa matua o "ngā taiao tāone mahi pai",[9] kāore tētahi e whakarato ana i te ārahitanga, ngā taputapu, te pūtea anō hei āwhina i ngā kaunihera kia whakatutuki i tērā. He mea nui e whakarōpū ana te NPS-UD i te takiwā tuwhera tūmatanui hei hanganga "tāpiri" – tētahi mea me whakaae ngā kaunihera "he nui te tūponotanga e wātea ai".[10] Hei whakatauaro, mō te hanganga "whanaketanga", arā ngā wai e toru me ngā whatunga ikiiki, e herea ana ngā kaunihera ki te whakarato i te raukaha rawaka ki te whakatutuki i te tono e whakaarohia ana mō te whare noho me ngā whenua pakihi mō te wā poto, waenga, roa anō hoki.[11]

## E tino hiahia ana tātou i te takiwā kākāriki?

Ka pātai pea ētahi, mēnā i roto i te tono nui mō te whare noho, he mea nui te whakarato me te tiaki i te takiwā kākāriki tāone. Nā te mea, ko ia mita pūrua o te whenua ka taea pea te whakawhanake e whakaritea kētia hei pāka, iari, māra, otaota rānei kāore e taea te whakamahi hei whare noho.

He mea nui ki te urupare ki taua pātai nā te mea kāore e taea te whakakore i ngā panoni e whakamahi ana mātou ki te āhua me te hanga o ō tātou tāonenui. Ki te kore e whakamahia tikahia, ko te tūraru ka hanga i ngā taiao kino ake, ā, hei a tātou haere ake nei. Kāore e iti iho i ngā āwangawanga e toru.

Ko te tuatahi, ko te tikanga o te ngarohanga o te takiwā kākāriki mō te hauora me te oranga o te hunga noho tāone. He wāhi rorirori, tere, hoihoi hoki ngā tāonenui hei wāhi noho. He mahi nui a te whai i ngā wāhi e tata ana ki te whakakori tinana, tūtakitaki rānei, kia puta rānei i te hoihoi o ia rā o te tāonenui kia whakarewa i te hauora hinengaro, tinana hoki. I miramirahia te hira o te takiwā kākāriki tāone i roto i ngā rāhui Kowheori-19 inakuanei, ā, nā ngā herenga o te haere ko te āhei ki ngā pāka me ngā papa rēhia he whakarauoranga mō ngā tāngata tokomaha.

Ko te āwangawanga tuarua e hāngai ana ki ngā ratonga taiao e whakaratohia ana te takiwā kākāriki. Mēnā i wareware mātou i te uara o ēnei ratonga, nā ngā takunetanga huarere nui rawa i maumahara ai anō tātou. I roto i te 18 marama e whakaritea ana tēnei pūrongo tērā te huinga o ngā takunetanga pōkākā nui i waiho i te whakamōtī i muri puta noa i Aotearoa. Kua tahia atu ngā mauhanga heke ua o ia rā, o ia marama i roto i Whakatū me Tāmakimakaurau hei tauira.[12] Kua pakaru ngā pūnaha wai pōkākā tawhito, e waipuke ana i ngā whare me ngā pakihi, ā, mā rātou anō e whakamā me te nui o te utu.[13]

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[9] NPS-UD, policy 2.2; RMA, schedule 3A, policy 3.

[10] NPS-UD, clause 3.5.

[11] NPS-UD, clause 3.2.

[12] MetService, 2022; NIWA, 2023. Hei tauira, tata ki te 280 mm o te ua i makere mai i Tāmakimakaurau i roto i te 24 hāora i te Paraire te 27 o Hānuere 2023, e whakaputa ana i te waipuke hira puta noa i te takiwā o Tāmakimakaurau. Kāore anō kia kitea tēnei takunetanga i roto i te mauhanga hītori, ā, he takunetanga 1 i roto i te 200 tau (NIWA, 2023).

[13] I waenganui i te Mei 2021 me te Hepetema 2022 neke atu i te $650 miriona o ngā kerēme inihua i tukuna mō te ngarohanga me ngā whakakino (Insurance Council of New Zealand, 2023).

Kua whakaatu ēnei takunetanga i te tūraru o te waihanga i ngā papa nui, mārō, kāore e taea kia whakawhitia, e kore rawa e taea te karo i te hekenga o te ua e tukuna ana e te kōhauhau mahana ake.[14] Ko tētahi urupare pea kia whakamārō anō – he nui ake ngā anga whakahaere wai pōkākā nui rawa me ngā waonga kaha ake o te whenua teitei me ngā taitapa moana. Engari, ahakoa ka whai take tērā, ka mauria mai e te panoni āhuarangi te kohuki paemahana. Kāore i tino rangona ngā mōrearea ngaru wera i Aotearoa, engari kāore e kore ka rangona – ā, ki te pēnā ka whakanuihia e te horanuku tāonenui o te raima, te arapāta me ngā tuanui pango te mamae o ngā kainoho tāonenui, ā, i ētahi wā, ka whakamōrea te oranga o ētahi tāngata.

He hātakēhi i te wā o te āwangawanga taiao e piki ana, he tokomaha ake ngā tāngata e noho ana ki ngā takiwā tāone e wehea ai i te taiao māori i tō ngā wā i mua. Engari e whakawhirinaki tonu ana te hunga noho tāone ki te taiao pērā i ngā wā i mua. Ka whakarato tonu ngā takiwā kākāriki i te whānuitanga o ngā ratonga waiwai, tae atu ki te whakaritenga paemahana, te whakahaere wai pōkākā, te wē tātari hau takiwā, te whakangaro waro me te whakarato nōhanga.

Ko te āwangawanga tuatoru e hāngai ana ki ngā painga tukuora, 'hanga wāhi' rānei e whakaratohia ana e te takiwā kākāriki tāone. Ahakoa he rerekē te tikanga o te tukuora tirohanga ki ngā tāngata rerekē, ko te marohi uara o te noho tāone apiapi e whakaarohia ana ka whakapai ake i ngā rākau me te otaota.

Kāore te uara o ēnei ratonga – ā-rēhia, ā-taiao, ā-tirohanga hoki – i te ōrite i ngā wā katoa. Hei anamata, ko te neke ki ngā tāonenui taupori apiapi, me ngā pānga e puta mai ana o te panoni āhuarangi, ka whakapiki te uara o ngā pāka tāone, ngā papa rēhia, ngā māra, ngā otaota me ngā rākau huarahi. Me āta whakaaro tātou mō ngā whakataunga whanaketanga tere nā te mea he uaua rawa te whakatū anō i te takiwā kākāriki ina ngaro ana, ā, he kino rawa pea mā ngā whakatipuranga e heke mai nei.

E hōhā haere ana au i te nui o ngā tuhinga e puta mai ana i te kāwanatanga matua, ā-rohe hoki e kōrero noa ana mō ngā 'taiao tāone kounga' e taea ana e ngā tāngata e 'noho, mahi, tākaro hoki'. Ko ēnei pahupahu kākāriki whakarata hei whakakapi i te tātaritanga kaha. Ki te whakapiki i te whakarato whare noho mā te whare noho apiapi ake, whakakī i roto i ngā rohenga onāianei o ngā tāonenui, me tauutuutu ki te rahi o te takiwā kākāriki tāone e noho tonu ana. Me whakaatu te whānui o taua tauutuutu, ā, me taupatupatu.

Kāore tēnei pūrongo i te rapu ki te whakawā he aha te nui o taua tauutuutu. Kāore hoki i te āta titiro ki ngā uara ahurea, hauora, tukuora hoki. Ahakoa he mea hira, e kōrerotia whānuitia ana ēnei. Ko te arotahi kē ki ngā ratonga taiao kāore e āta whakaarohia. Ko te tūmanako mā tēnei pūrongo e whakapai ake tō mātou mārama he pēhea, ā, ki hea e panoni ana te takiwā kākāriki, ā, he aha ai, ā, he aha ngā tukunga iho o aua panoni. Ko te mea hira, ka titiro ki te katoa o te takiwā kākāriki – tūmatanui, tūmataiti hoki – ā, ka whakamatau ki te tohu i ngā ratonga taiao, uara hoki me aroturukihia, me whakarato hoki ina kukune ai te āhua tāone me te apiapi.

[14] Hei tauira, he 10-15 ōrau te kaha ake o te heke o te ua i Ōtautahi i te Mei 2021 nā te whakaaweawe tangata ki te pūnaha āhuarangi. Ko ngā pikinga āhua ōrite (5-10 ōrau) o te kaha o te heke ua i tātaia mō te pōkākā i mau mai i te waipuke ki Buller i te Hūrae 2021 (Stone mā., 2022).

Mātāpuna: Google Maps

**Hoahoa O.4: inakuanei kua neke mai i te whare noho tūtahi i roto i ō tātou tāonenui, ā, kua hiahiatia kētia ngā whare tāone/ngā whare tuarua (i runga – Rototuna, Kirikiriroa) me te whare noho parehua (i waenga – Avondale, Tāmakimakaurau). He āhua ōrite te tuari mākete o ngā wharenoho (i raro – Hobsonville, Tāmakimakaurau).**

## He ārahi tere ki tēnei pūrongo me ana kitenga

Ka mutu te whakawātea i ngā take whakamārama mō ngā takiwā kākāriki me ngā ratonga e whakaratohia ana (upoko tuatahi), ka tāpaetia e te pūrongo ngā hua o te tātaritanga taunakitanga i kirimanatia ki te tuhi i te panoni i te takiwā kākāriki i te hipanga o te wā (upoko tuarua).

Ka mātai te upoko tuatoru i te āhua o te whakaaweawe o te pūnaha ture, waeture hoki onāianei i te whakaratonga me te tiakitanga o te takiwā kākāriki i roto i ō tātou tāonenui. Ka whakahua i ngā taputapu me ngā ahunga e whakamahia ana e ngā kaunihera ki te whakarite i ngā pāka tūmatanui hou me ngā papa rēhia, tae atu ki te hunga e whakaaweawe ana i te tuaritanga o ngā iari, ngā māra me ngā rākau tūmataiti.

Hei mea whakawero, e tiro ana te upoko tuawhā ki anamata. Ka aromatawai i te wāteatanga – me te uara – o te kuneroa o te takiwā kākāriki tāone hei urupare ki ngā ia wā roa e rua: te apiapi tāone me te panoni āhuarangi. Ka whakatau te matapaki he nui te tūponotanga ka iti rawa te ratonga o te takiwā kākāriki (ā, he nui te taumahatanga) i te wā e tino hiahiatia ana ngā ratonga. Ka puta mai ētahi pātai hira mō te hunga e herea ana ki te whakarite i te āhua o te whanaketanga tāone ināianei.

E whakatakoto ana au i ētahi marohi e hoahoatia ana ki te whakatūturu e tino kautehia ana te tāpaetanga a te takiwā kākāriki ki ngā taiao tāone i roto i te hoahoa tāone anamata, kaua ko te whiu ki te taha hei taupoki whakarākei (e iti haere ana). E āmikihia ana ēnei i roto i te upoko tuarima, ā, kei roto ko:

- Te whakatūturu ko te whānuitanga o ngā ratonga e whakaratoa ana e ngā takiwā kākāriki, me te whānuitanga o te whakahē a te whanaketanga tāone, e āta aromatawaihia ana e ngā kaunihera kia whakaritea ngā tauutuutu i runga i te mōhio.
- Kia ōrite te aroturuki me te ine i te whānuitanga o te takiwā kākāriki.
- Ko te whakatenatena i ngā kaunihera me ngā tari kāwanatanga hāngai ki te mahi kia whakapai ake i te kounga, te nuinga hoki/rānei o te takiwā kākāriki ki ngā paenoho e iti haere ana, he iti rawa rānei.
- E arotake ana i te āhua o te hanga anō i te takiwā kākāriki i muri i te whanaketanga rō tāonenui me te apiapi, me te āhua o te whakarite i te takiwā kākāriki i roto i ngā whanaketanga whīra kākāriki.

**Simon Upton**

**Te Kaitiaki Taiao a Te Whare Pāremata**

# 1

*Cheilanthes distans*

# What is urban green space and what can it do for us?

## What is urban green space?

This report is about urban green spaces: what they are, what services they provide, where they are and how they are changing.

For the purposes of this report, urban green space is any urban land that is not covered by a structure or sealed by an impermeable surface such as asphalt or concrete. Thus, while most green spaces are covered in some form of vegetation (hence the word 'green'), they can also include areas of temporarily bare soil, or even soil covered in permeable cover such as mulch, woodchips and gravel or permeable weed mats under larger plants. This broad definition of green space also includes wetlands. In a basic sense, green space is space that preserves at least some biological processes.

This report considers all urban green space, regardless of whether it is on private or public land. It includes everything from lawns and vegetable gardens to dense native bush patches, planted roadside berms, riparian strips, playing fields, golf courses and civic areas planted with trees and other vegetation. This reflects an underlying focus of this report on the *environmental* benefits provided by urban green space. Unlike recreational and social benefits, the ownership status of the green space in question matters little for things like temperature regulation, stormwater management, air filtration and provision of habitat.

That is not to say that the broader amenity, recreational, health and wellbeing benefits of urban green space are unimportant. For many people, the ability to escape to a nearby park to exercise or socialise is probably the biggest benefit associated with urban green space. That fact has spawned research that estimates what property buyers are prepared to pay to live close to public green space (Box 1.1).

**Box 1.1: Proximity to parks: what prospective homeowners are prepared to pay**

Hedonic pricing is a tool that can be used to value many of the non-market goods and services that nature provides. It has been widely applied in the housing market to estimate how people value environmental amenities – sunshine, views, or public open space etc – and disamenities – air pollution or noise, for example.

In general, hedonic analysis is best suited to valuing those benefits that are tangible or perceptible to people. In the context of urban green space, that probably means it is better at capturing the value associated with recreational use and visual amenity than things like stormwater management, temperature regulation or air filtration.

There is a large international literature that uses hedonic pricing to disentangle what people are prepared to pay to live close to parks and reserves. For example, based on a meta-analysis of 37 primary hedonic pricing studies, Bockarjova et al. conclude that "urban nature has an impact on house prices in the areas surrounding it, and that the magnitude of this effect decreases as house distance from nature increases".[1] Similarly, on the basis of 53 primary studies, Waltert and Schläpfer conclude that "open space and forest frequently increase the prices of neighboring properties".[2]

The literature in New Zealand is much less extensive, and focuses almost solely on Auckland. While it is clear that people are prepared to pay a premium to live close to the coast, there is limited evidence of a premium for parks or reserves. Several explanations have been offered for that. Nunns and Allpress note that "this does not necessarily mean that parks are not valued in Auckland, but that their value accrues broadly to most Auckland houses and flats, regardless of whether they are immediately next to a park".[3]

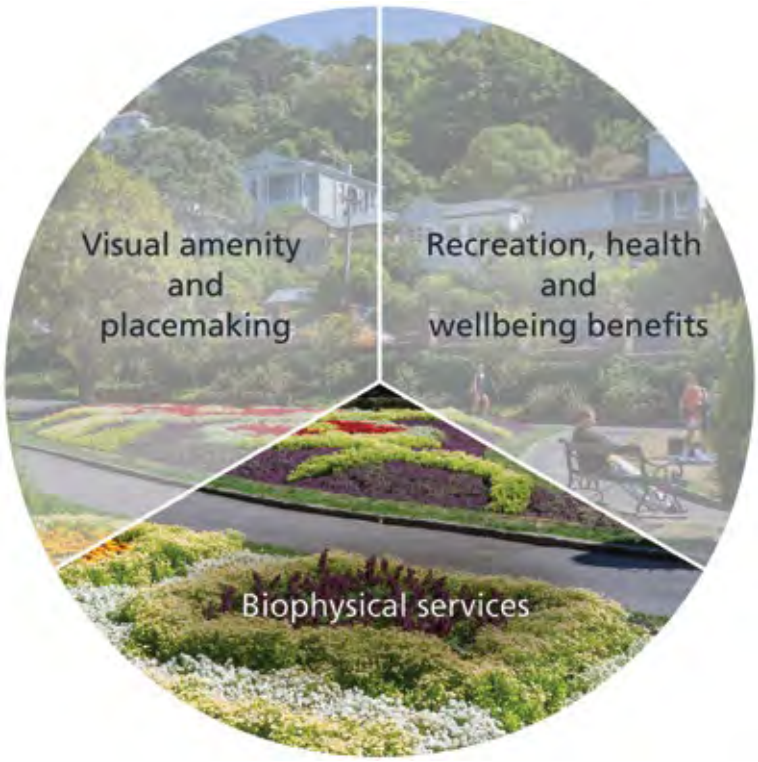
Importantly though, there is some evidence of a price premium in those studies that differentiate between different types of dwellings. Nunns and Allpress, for example, find a price premium in the order of 15% for Auckland apartments situated close to parks.[4] As the authors note, this seems intuitively reasonable given that apartment owners typically have little access to private green space, and therefore seek proximity to public green space as a substitute.

[1] Bockarjova et al., 2020, p.302.
[2] Waltert and Schläpfer, 2010, pp.147–148.
[3] Nunns and Allpress, 2016, p.40.
[4] Nunns and Allpress, 2016.

## The benefits of urban green space

The benefits provided by urban green space are many and varied but can be grouped into three broad but overlapping categories (Figure 1.1).






Source: PCE

**Figure 1.1: The benefits of urban green space can be broadly grouped into three broad categories: visual amenity and placemaking; recreation, health and wellbeing benefits; and biophysical services such as temperature regulation and flood prevention. This chapter focuses on describing the biophysical services.**

The first category embraces the recreation, health (including cognitive function) and wellbeing benefits associated with having green spaces to exercise, socialise, play, relax and even commute in. These benefits have been extensively canvassed globally and have been further supported by research here in New Zealand.[5,6] Public parks and reserves and private gardens offer urban dwellers an important alternative to the asphalt, concrete, glass and steel of city life. These benefits are not the primary focus of this report and are not dealt with further in this chapter.

[5] The list of health and wellbeing benefits is long and widely acknowledged. Among other things, green spaces have been linked to lower blood pressure, heart disease, asthma and obesity, improved mood and cognition lower rates of depression. Numerous reviews summarising the literature are readily available (e.g. WHO, 2017).

[6] In a recent example, spending time in green space was found to have a positive impact on the wellbeing of New Zealanders during lockdowns caused by the Covid-19 pandemic (Ministry for the Environment, 2022c).

The second category is the visual amenity or 'placemaking' benefits provided by trees and nature. Visual amenity is highly subjective. Some may value an expanse of manicured lawn or a neat garden of exotic plants, others a patch of native bush, a wetland or wild meadow. Not everyone attaches the same value to being surrounded by 'green' either, but for many people visual amenity is an important part of what constitutes a good place to live. Placemaking is a key component of contemporary planning and resource management. Again, this has been extensively canvassed and is not covered in detail here.

The third category of benefits provided by urban green space can broadly be described as biophysical services. These include temperature regulation, carbon sequestration, flood mitigation, erosion control, food provision, air and water filtration and habitat for biodiversity. There is growing international recognition of the importance of these services in cities – hence the widespread adoption of terms such as 'green infrastructure' and 'nature-based solutions'.[7,8]

This chapter focuses on four key biophysical benefits that urban green spaces provide: water management, heat reduction, improving air quality and biodiversity provision. These have been selected from the wider pool of biophysical benefits because they have the potential to provide significant tangible environmental value. While carbon storage and sequestration is sometimes touted as a benefit of urban green spaces, its contribution to the national carbon pool is comparatively minor, and changes (loss or gains) are hard to quantify. That said, some parks and reserves that are being allowed to regenerate back into forest are sequestering more carbon. An example of this is the Mākara Peak Mountain Bike Park in Wellington. This land was retired from farming in 1998 and is now mostly covered in a growing forest canopy. These larger blocks are sometimes eligible to receive carbon credits through the New Zealand Emissions Trading Scheme, providing revenue for councils as they grow.[9]

Classifying benefits in this way does not necessarily align with a te ao Māori perspective. A te ao Māori lens would connect these benefits through whakapapa. In this world view, there are no neat distinctions between health and wellbeing benefits, placemaking, visual amenity, cultural needs and biophysical processes. As such, the health of the connections between all species is what matters and determines the mauri of a place.[10]

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[7] European Commission, 2021.

[8] Some of the reported benefits of green spaces are difficult to quantify because they are based on the social and cultural preferences of the urban population in question. As such, green infrastructure can be described as both social and biophysical infrastructure (IWUN, no date).

[9] Wellington City Council (2022a) received 14,004 carbon credits in recognition of the carbon absorbed by a portion of their green belt in 2022.

[10] McGowan, 2021.

## Urban green spaces and water

Cities have major impacts on the natural water cycle, affecting the amount of water moving through the area: how fast it moves, where it goes and its quality. The surfaces created by most buildings, roads, footpaths and driveways are impervious – they limit the spaces where rainwater can soak into the ground.[11] As more of the urban surface is made impervious, the volume of water that needs to be artificially managed increases so that even smaller rainfall events can present problems. While flooding naturally occurs in some areas, impervious surfaces cause larger than normal volumes of water to flow over the surface of the land more quickly and more frequently. Fast-moving surface water can be very damaging, eroding land and redistributing pollutants and sediment. In some cities with combined sewers, increased impervious surface can result in more frequent overflows of untreated sewage.

Conventional stormwater systems are designed and engineered to cope with rain to specific levels. But if a system becomes overwhelmed by a large storm event, increased pressure from new development or lack of maintenance (e.g. blockages) various problems can and often do occur.

Current measures to reduce stormwater impacts from new developments may be insufficient to avoid sedimentation, pollution and water flow problems. A recent study in Hamilton found that measures to reduce downstream scouring in a new development still led to four times the volume of runoff compared with not having the development.[12]

Pollutants, including sediment, washed from buildings, roads and other urban surfaces also commonly find their way into stormwater systems.[13] They can cause considerable damage to receiving urban infrastructure and downstream ecosystems such as rivers, lakes, estuaries and harbours.

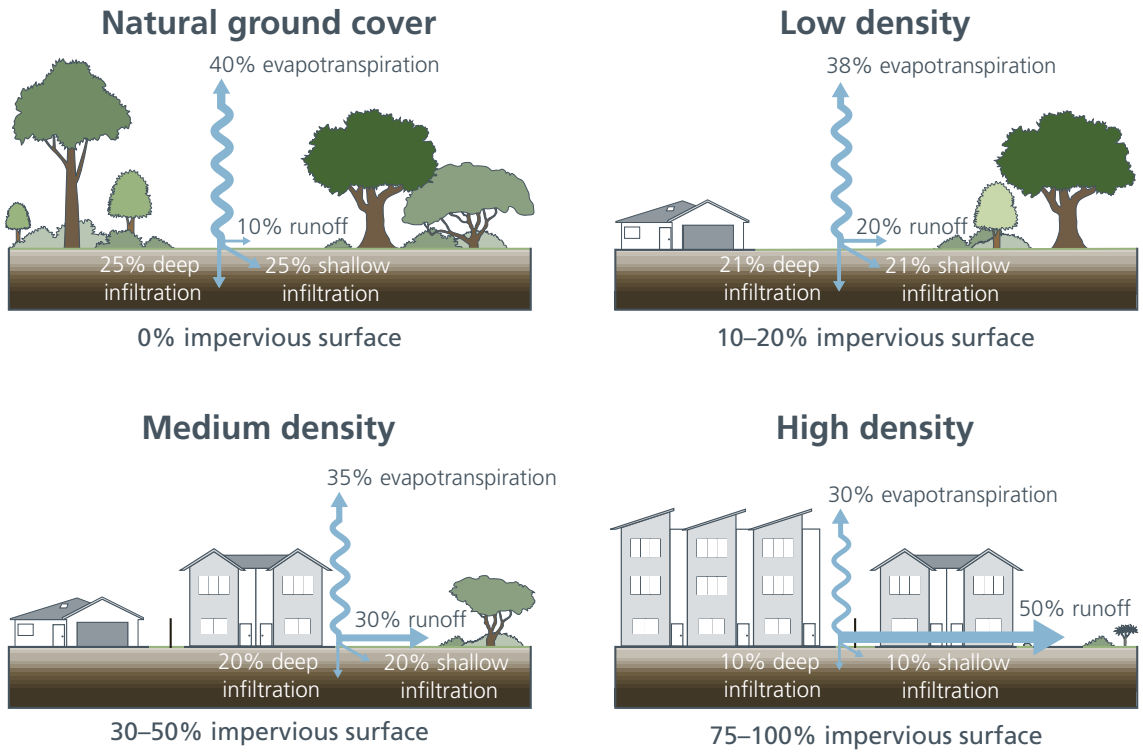
Much urban development severs the dynamic connections that exist between surface and groundwater (see Figure 1.2). Impermeable surfaces reduce the proportion of rainfall that replenishes underlying water tables and groundwater. As a consequence, some urban streams, rivers and aquifers run more slowly and at lower levels in summer than they would otherwise throughout the year. In the Hutt Valley, concerns about aquifer recharge – and the health of Te Awa Kairangi/Hutt River – have led to the creation of a protected groundwater zone.[14] This limits the area of land that can be sealed.

[11] In larger cities, if enough ground is sealed or covered, then the resulting changes to the water cycle can lead to weather patterns themselves being altered.

[12] Phillips and Lillis, 2018.

[13] The so called 'first flush' of water that flows at the start of a rain event is known to be particularly contaminated and is often diverted from rainwater storage systems for this reason.

[14] See https://www.lawa.org.nz/explore-data/wellington-region/water-quantity/groundwater-zones/wellington-harbour-and-hutt-valley/.




Source: Adapted from Livingston and McCarron (1992) and Arnold and Gibbons (1996)

**Figure 1.2: The way water moves through a forest can be very different to the way it moves through different parts of a city.**

## How can green spaces help with urban water issues in New Zealand cities?

Green spaces act like giant sponges, slowing the flow of rainwater and trapping and filtering pollutants.

When rain falls on a patch of bush or forest, or even a lawn, some of the water is caught by the vegetation. Evaporation from these plant surfaces means that some rainwater (a third by some estimates) never reaches the ground.[15] Rainwater that does reach the ground is less likely to pool on the surface than rainwater that falls on impervious surfaces. Some percolates into the soil where it is stored in leaf litter layers and soil pores. Some is taken up by plant roots (before being returned to the atmosphere via transpiration) while some percolates deeper, recharging groundwater systems that replenish rivers and streams.

[15] US Department of Agriculture, 2020.

Healthy, deep soils with leaf litter layers can hold large amounts of water. Generally speaking, the deeper the soil, the more water it can hold and filter. Plants help by increasing the volume of soil and by loosening compacted ground, allowing water to enter the soil more quickly (reducing runoff) and to travel deeper. The roots of trees and wetland plants such as sedges and rushes can be particularly helpful in this regard.[16,17] Conversely, soil compaction reduces the absorption of water. Dry lawns can have a similar effect causing water to run off rather than percolate. It has been estimated that urban vegetation can help retain a third of the water resulting from extreme rainfall events.[18] In Portland, Oregon, stormwater rates relief is offered to properties with trees on them, based on their size.[19]

Urban planners, stormwater engineers and landscape architects are increasingly seeking to mimic these natural processes to manage stormwater flows and minimise water pollution in our cities. This approach, known as water-sensitive urban design, seeks to protect and enhance natural freshwater systems and sustainably manage water resources.[20,21] In practice, it can involve excluding certain areas from development (e.g. floodplains, wetlands), restricting the extent of impervious surfaces, and promoting green devices that retain, detain and filter stormwater. Retaining water on site can allow for its re-use for purposes such as flushing toilets or watering gardens, thus conserving potable water.

Auckland Council's comprehensive guidelines for stormwater management devices list some of the options available to manage stormwater.[22] Many of these devices are considered 'green' infrastructure in that they employ living components as part of their design. Also known as engineered green solutions, these devices include living roofs, vegetated swales, rain gardens, tree pits, planter boxes, wetlands and ponds.[23] While they may contain pipes, concrete, gravel and fabrics, they are at their core a living ecosystem. Most of these green structures function as biofilters trapping and storing sediment and pollutants, which also help to protect other urban natural areas (including blue spaces like lakes and estuaries). In time, biofilters will lose their capacity to trap material and will need to be replaced. Effective design and construction followed by timely maintenance are therefore the key to their success. Well-maintained biofilters can be very long-lived in residential areas and function as self-watering green spaces.

The stormwater performance of these devices depends significantly on the location, shape and size of each element within the system. The depth and type of soils and the plant species chosen will also be important factors. For example, a swale of mown grass growing on a thin layer of soil will not be as effective at slowing or filtering water as one that has deeper soil with unmown, taller plants on it.[24] Auckland Council's design guide recommends that soil for planting should be at least 300 millimetres for grasses, increasing to 600 millimetres for shrubs and 1,000 millimetres for trees. A suitable soil profile not only manages water better – it allows for more vegetation too.

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[16] Beral et al., 2023.

[17] US Department of Agriculture, 2020.

[18] Richards et al., 2022.

[19] City of Portland, no date.

[20] Fletcher et al. (2014) detail some of the various terms used to describe nature-based solutions.

[21] Auckland Council, 2017a.

[22] Auckland Council, 2017a.

[23] Commonly designed to hold (bioretention) or delay water flow (biodetention).

[24] In a similar vein, 'daylighting' (opening up a culvert or pipe) a stream and creating riparian strips can also provide filtering benefits and help control stormwater flows.

While there are fundamental differences between the characteristics and functions of a natural green space, such as a block of native bush, and those of an engineered system, such as a rain garden, both can be beneficial elements of a wider green space network within a city.

Quantifying the precise contribution of green spaces to the management of stormwater flows is not straightforward. The wider context, such as the connectivity and movement of water throughout the entire catchment, must be taken into consideration. However, some data are available. Wellington Water's *Regional Standard for Water Services* states that where impervious surfaces cover more than 65% of an urban area, the peak rate of overland rain runoff is almost three times higher than that of green spaces.[25]

Sealing the ground with impervious surfaces not only increases peak rates but also increases the frequency of runoff occurring from smaller events too.

An online tool used by Auckland Council provides further insight into what impervious surfaces can mean for runoff.[26] Using the tool, the change in runoff was calculated for a 1,000 square metre plot of land in central Auckland where the impervious area was increased from 20% to 60% (i.e. the equivalent of three townhouses where previously there was a single residence). The tool predicted that with 24 millimetres of rain over 24 hours, the runoff volume from the plot would increase from 0.59 cubic metres to 12.08 cubic metres – 20 times the original runoff volume.

## Urban green spaces and temperature

Urban areas have higher air, soil and water temperatures.[27] The air temperature in heavily built-up urban areas is often several degrees higher than it is in surrounding rural areas. These higher urban temperatures occur because some of the incoming solar radiation is trapped in buildings, streets and other structures, which act as radiators. Furthermore, cities are often devoid of vegetation and therefore lack the natural cooling effect of shading and plant transpiration. This is known as the urban heat island effect (Figure 1.3). High urban air temperatures add to energy demands, place stress on infrastructure and ecosystems, and cause undesirable health outcomes, including some deaths. The elderly and young are most vulnerable, particularly at night.[28]

The number of people exposed to harmful urban heat will only increase as urban populations continue to grow and climate change intensifies.[29,30]

[25] Based on Wellington Water, 2019, table 7.1, p.96.

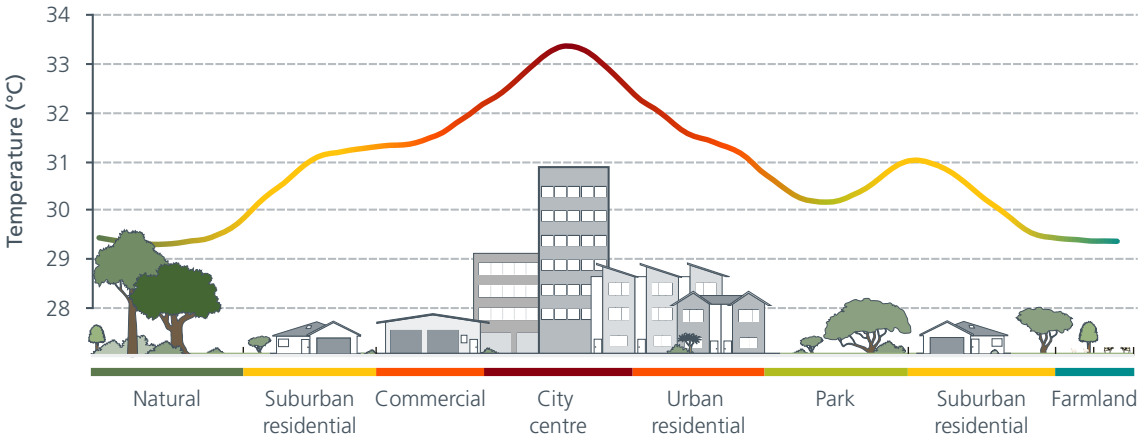
[26] See https://tools.aucklandcouncil.govt.nz/storm-water-device-sizing-tool/#/retention-and-detention.

[27] Heating soil can have many impacts – altering what can grow.

[28] Heat-related health issues are known to be exacerbated when temperatures remain comparatively high at night and extend for multiple days denying the body respite from the heat (Harrington and Frame, 2022).

[29] Liu et al., 2022. Hot days (> 25 °C) could quadruple by 2100 in many regions if emissions are not abated (Ministry for the Environment, 2018).

[30] Tuholske et al., 2021.




Source: Adapted from US EPA (1992)

**Figure 1.3: An urban heat island formed over a city. The hottest areas are concentrated in the most built-up areas.**

Problems arising from urban heat are occurring in temperate cities too, not just in those with already hot climates.[31] A 1999 study in Christchurch found that once temperatures were above 20.5 °C, each further increase of 1 °C was associated with a 1% increase in mortality.[32] Temperatures often reach over 21 °C in many cities around New Zealand today, and hotter extremes can be expected in the future.[33,34]

A recent analysis of the impact of urban green space on heat-related mortality looked at 452 cities from 24 countries around the world. The study found that cities with more green space had a lower risk of heat-related mortality. A 20% increase in green space was associated with a 9% reduction in mortality.[35]

Excess heat can stress all living things, not just people. Plants adjacent to hot, dry surfaces such as concrete are particularly vulnerable. If water supply is inadequate due to poor soil provision, then plants may not be able to adequately cool themselves.

While less apparent, urban water is often excessively warm too as a result of runoff being heated as it runs over hot city surfaces. Piping this into waterways can be harmful for aquatic ecosystems.[36]

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[31] Above-average seasonal temperatures can be harmful regardless of actual temperature (Royal Society, 2017; Harrington, 2021). Thermal comfort is not just related to air temperature – other important factors include humidity, solar radiation, wind and susceptibility of the population. Recent research has found that even healthy young people tolerate much lower temperatures than previously thought in high humidity conditions (Guo et al., 2014; Gasparrini et al., 2015; Bohn, 2022).

[32] Hales et al., 2000.

[33] According to data from Manatū Hauora – the Ministry of Health, "exposure to excessive natural heat" was recorded as the underlying cause of death of four people in New Zealand between 2000 and 2018 – all in the North Island (although one of these was related to a thermal hot pool incident). Many more have been hospitalised. In the most recent year for which data are available (2018/19), there were 61 publicly funded hospital discharges where the first reported external cause of admittance was exposure to excessive natural heat. (Health New Zealand, pers. comm., 22 September 2022). Harrington and Frame (2022, p.1) provide the first detailed summary of the "severity, frequency, and persistence of extreme heat experienced by local communities in New Zealand."

[34] This concern has been reflected in the development of a heat alert system that was piloted around New Zealand over the 2021–2022 summer. See https://www.wgtn.ac.nz/news/2021/12/heat-alert-project-aims-to-help-reduce-health-impacts-from-warming-climate.

[35] Choi et al., 2022.

[36] Young et al., 2013.

## How do green spaces help cool New Zealand cities?

Green spaces in cities can cool their immediate surroundings, providing a vital service to cities facing problems from excess heat.

Everyone is familiar with seeking shade under a tree on a hot day or the cool relief of walking into a forest. Trees, with their multiple layers of leaves or needles, are excellent at providing shade.[37] This effect can be quantified. A recent study found trees growing in Wellington playgrounds block 80% of direct solar ultraviolet radiation.[38] In addition to shade canopy, even simply being near well-watered, lush vegetation is usually cooling. This is because most plants lose water and cool the air as they grow via a process called evapotranspiration.[39] Street trees have been reported to provide air temperature cooling of between 0.4 and 4.5 °C, with the effect on temperatures strongest within 30 metres of the trees.[40] The cooling sensation experienced by an individual standing in tree shade is substantially larger again than the measured air temperature cooling impact of trees.

Green roofs are an effective way of reducing building temperatures in summer by insulating them, reducing the solar energy absorbed, and allowing for more efficient air-conditioning systems.[41]

Large parks provide cooling benefits well beyond their boundaries. A global study of over 30 urban parks found that those over ten hectares (about 14 football fields in size) had the highest average cooling extent and intensity, amounting to a temperature reduction of up to 1.2 °C and extending up to 350 metres from the park boundary.[42]

European cities are currently warming at about 0.5 °C per decade compared with the surrounding rural areas. But they are also greening, and this greening is offsetting the warming by 0.1 °C.[43] Therefore, green spaces are offsetting about 20% of the warming from the urban heat island effect. Research from the United States suggests that extensive urban greening efforts could provide upwards of 3 °C of cooling but would not offset high-intensity global warming.[44] There are no equivalent New Zealand data.

The size and condition of the plants in a green space are important determinants of the cooling they can provide. Trees provide more cooling than lawns due to their combined canopy shading effect and evapotranspiration.[45] Diverse, dense, healthy forests provide the most significant cooling effects.[46] Auckland Council's response to the Government's recently promulgated Medium Density Residential Standards explicitly recognises the cooling function that trees provide. Plan Change 78 to the Auckland Unitary Plan contains an objective that requires development to "reduce the urban heat island effects of development and respond to climate change, by providing deep soil areas that enable the growth of canopy trees."[47]

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[37] The sunshade and the cooling provided by trees also depends on location, situation, season, and time of day.

[38] Gage et al., 2018. Tree shade is not unique in this sense – there are other ways of providing shade.

[39] A consequence of plants exchanging gases with the atmosphere is that water is vaporised from their leaves; this water loss effectively cools the leaves of the plant and the surrounding air.

[40] Kurn et al., 1994; McDonald et al., 2016; Taylor et al., 2016.

[41] US EPA, 2018.

[42] Aram et al., 2019.

[43] Liu et al., 2022.

[44] Krayenhoff et al., 2018.

[45] Tiwari et al., 2021; Wu et al., 2021.

[46] Vegetation density is an important predictor of cooling (Yan et al., 2021). More diverse green space has been found to provide more cooling too (Wang et al., 2021).

[47] Auckland Council, 2022i, p.114.

Importantly, plants provide little to no cooling due to evapotranspiration in unusually dry weather conditions. In extreme cases such as droughts, water stress can go beyond the plants' ability to cope and the plants die. Hence a burnt dry lawn will provide little relief from heat.[48] By contrast, trees are able to withstand drought much more readily than turf. They can continue to provide cooling for longer than smaller forms of vegetation.

Most of New Zealand's cities are located in coastal areas and are heavily influenced by the ocean.[49] Hence, while vegetation will still provide some cooling, the extent and location of this benefit will be influenced by wind direction, urban form and land form.[50] Wellington has seen comparatively little increase in abnormally hot days due to climate change over the last 80 years compared to other New Zealand cities, in no small part because Wellington is coastal and particularly windy.[51]

A further consideration in New Zealand is that shade and cooling are not always desirable. While summer cooling can be beneficial, shade in winter can be unwelcome, as many residents in southern cities will attest. Deciduous trees may sometimes be preferable as they provide shade in summer and allow for sunshine in winter.

## Urban green spaces and air quality

Clean air is essential for the health of living things. That health can be seriously compromised by gaseous pollutants and particulates (solid particles that are light enough to be suspended in air), particularly in urban areas. Green spaces – in particular, trees, hedges, green walls or screens – can help to cleanse the air.

Air quality in New Zealand cities is generally considered to be good in comparison with those in many other parts of the world. But in parts of some of our cities, air quality is sufficiently bad to raise health concerns. A 2022 study of air quality in New Zealand found that human sources of air pollution are leading to over 3,000 premature deaths (in people aged 30 and over) and 13,000 hospitalisations annually, costing the country more than $15 billion in 2016.[52] The study also concluded that, overall, air pollution was 10% worse in 2016 than it had been a decade earlier.

To put these findings in context, they place the estimated death toll from air pollution at roughly ten times the road toll.[53] Over 2,000 of these air quality-related deaths were attributed to pollution caused by vehicle emissions. According to the study, nitrogen dioxide emissions from vehicles surpassed particulate matter smaller than 2.5 microns in diameter ($PM_{2.5}$) as the principal source of harm from air pollution in New Zealand, a surprising finding given the many known detrimental health impacts of small particulates.[54] At high concentrations, nitrogen dioxide can also injure plant leaves and reduce growth, although at moderate levels it can act as a fertiliser.[55]

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[48] Gill et al. (2007) modelled that maximum surface temperatures of school grounds in Manchester (UK) would be 14 °C hotter when the grass dries out. Similar concrete and dry lawn surface and air temperatures were recorded by Fung and Jim (2019), whereas forested areas were about 4 °C cooler.

[49] Ongoing climate change is known to cause increases in marine heatwave frequency and intensity (Wernberg et al., 2021).

[50] Urban areas will experience the effects of excess heat in various unique ways, depending on factors that include the size and shape of the city, types of buildings and other infrastructure that exist, patterns of land use, climate, and local weather patterns (ESMAP, 2020).

[51] Daalder, 2021.

[52] "If there was no air pollution (ie $PM_{2.5}$ or $NO_2$ from human-made sources) in New Zealand, then about 3,300 deaths would have been avoided in 2016. This represented about 11% of all deaths in New Zealand in 2016." (EHINZ, 2022).

[53] Around 300 people die each year on New Zealand's roads (Te Manatū Waka, 2023).

[54] Ministry for the Environment and Stats NZ, 2021; EHINZ, 2022.

[55] Takahashi and Morikawa, 2014.

The findings indicate that harm from air pollution is worse where there are large concentrations of vehicles – particularly where they are moving slowly and stopping and starting often. Busy streets and motorways in urban centres are therefore likely to be particularly harmful places to be.[56]

## How do green spaces help improve air quality in New Zealand cities?

Trees and shrubs are regularly planted in cities around the world to reduce urban air pollution.[57] A shrub or tree's ability to remove pollutants and filter particulate matter from the air is often reported as one of its main quantifiable benefits – one that can even be valued in economic terms using popular online tools such as i-Tree.[58] All plants can filter the air by either trapping the unwanted pollution on their leaves (from which it is washed off by rain) or absorbing it into the plant itself, but trees are particularly effective because they have the highest surface leaf areas.[59] Trees in Auckland have been estimated to remove 1,230 tonnes of nitrogen dioxide, 1,990 tonnes of ozone and 1,320 tonnes of particulate matter annually.[60]

For vegetation to successfully remove pollutants and filter particulate matter from the air, the leaf area and type (especially hairiness) and the location of plants relative to the source of pollution and the sites they are protecting are important.[61] So is the shape of the built urban form. In a 2016 study of 245 cities, the Nature Conservancy noted that plants provide most benefits locally, with the greatest reductions in particulate matter occurring within 30 metres of vegetation, and very little reduction beyond 300 metres.[62] Therefore, a dense planting of shrubs and trees between a busy road and the footpath should help protect pedestrians from car-related air pollution.[63]

The way vegetation alters wind flow is also relevant. Plants are commonly planted as windbreaks or shelterbelts. The type of plant and its size can alter how much air moves through versus over or around it. Windbreaks are often desirable from a shelter point of view but their ability to block or redirect air flow can improve or worsen air pollution depending on location. It is also possible for vehicle emissions to be trapped under the canopy of street trees.[64]

Many studies have found a positive correlation between the provision of urban green space and respiratory health. But there are, equally, studies that show either inconclusive or negative associations with air quality and vegetation.[65,66] One of the reasons for these conflicting results is the fact that some plants are themselves a source of pollutants.

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[56] Tonkin & Taylor, 2022, p.10.

[57] McDonald et al., 2016; Eisenman et al., 2019.

[58] i-Tree is a well-known suite of tools for estimating the benefits of urban trees, including how much $PM_{2.5}$ and nitrogen dioxide they can remove for a given size of a particular species of tree. It has now been calibrated for New Zealand, but its use here is still in the research and development stage (University of Canterbury, pers. comm., 11 January 2023). See https://www.itreetools.org/.

[59] Filtering ability varies by species – and the total surface area of all the leaves on a tree can be considerable, one report claiming that 660 $m^2$ of surface area can be assumed for 1 $m^2$ of plant area (Cavanagh and Clemons, 2006; Arup, 2016).

[60] Cavanagh and Clemons, 2006.

[61] Which is why green walls or green screens are effective where they intercept air flow (Pugh et al., 2012).

[62] McDonald et al., 2016.

[63] Excess noise is of growing environmental urban concern, but the ability of urban green spaces to help reduce sound levels (by acting as a barrier) is actually comparatively small (European Commission, 2017).

[64] Salmond et al., 2013.

[65] Mueller et al., 2022.

[66] For example, Vos et al. (2013, p.113) stated that "our results strongly indicate that the use of urban vegetation for alleviating a local air pollution hotspot is not expected to be a viable solution."

Aside from the well-known gases they exchange with the air (such as oxygen, water vapour and carbon dioxide), plants also release various other gases and compounds, including volatile organic compounds (also known as VOCs). For example, mowing lawns releases not just emissions from mowers that burn fossil fuels but also VOCs from the plants themselves.[67] These VOCs can interact with other pollutants in the air in a myriad of ways. Plants also release pollen at certain times of the year, some of which can trigger allergies.


Source: Elliot Blyth, Unsplash

**Figure 1.4: Mature trees shading Manners Street, Wellington. The relationship between green space and air quality is clearly complex.[68] Some urban trees may degrade local air quality rather than improve it.[69] Nevertheless, available evidence indicates that the right plants in the right places provide modest but meaningful benefits.**

[67] de Gouw et al., 1999.

[68] Causal pathways between urban trees, air quality and asthma are very complex and include numerous interacting processes (Eisenman et al., 2019).

[69] Cavanagh and Clemons, 2006.

## Urban green spaces and biodiversity

Biodiversity loss is a worsening global problem, the major drivers being habitat loss and fragmentation, introduced animal and plant pests, disease, land use and climate change.[70] Cities are not immune to these drivers. Habitat loss and the resultant severed ecological connections are common and compound the ecological damage and pollution associated with urban activities.

Many of New Zealand's urban areas are located in areas that were once biodiversity hotspots.[71] As a result, while urban areas make up a very small proportion of the total lowland area of New Zealand, they still contain a disproportionately high number of nationally important, rare and threatened environments.[72] Indigenous vegetation cover is estimated now to be less than 10% of what it once was in these lowland areas and, unsurprisingly, is generally lowest in the centres of the largest cities.[73] This is important because it has been postulated that a minimum of 10% of each environment needs to be maintained for the species in it to persist. Urban areas and the biodiversity they contain also form an integral part of wider ecological systems operating at the catchment or landscape scale. Town 'green belts' (as in Wellington and Dunedin), stepping stones that include wetlands and estuaries (as in Christchurch and Auckland), and gully links (as in Auckland, Hamilton and Tauranga) are critical components that support biodiversity.

According to Stats NZ – Tatauranga Aotearoa, around 86% of New Zealand's population lives in cities. And while the conservation estate covers around a third of New Zealand's land area, much of it is located in remote or otherwise difficult-to-access areas. As Catherine Knight noted in her recent book *Nature and Wellbeing in Aotearoa New Zealand*, "While our national parks are places of spectacular wilderness, for many of us, these places are out of reach."[74]

People's lives are enriched through a connection to nature and through the social interactions and connections that result from the existence of open public space.[75] Green spaces can be inspiring, educational and healing. They are a source of reconnection with the natural world – a connection that has been severely attenuated by urban living.

Access to nature is of critical importance to Indigenous cultures that are more inclined to see humans as a part of the natural world. For Māori in Aotearoa New Zealand, this view of nature encompasses a framework where all aspects of nature are intertwined and connected through stories of whakapapa, linking Māori to their natural and spiritual environment.[76]

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[70] IPBES, 2019.

[71] Because they are located on intersection of coasts and rivers, and lakes – i.e. lowland productive ecosystems.

[72] Clarkson et al., 2007.

[73] Clarkson et al., 2007.

[74] Knight, 2020.

[75] Enriching people's lives through connection to nature is a national target that aligns with the Convention on Biological Diversity's global strategic goal of addressing the underlying causes of biodiversity loss by mainstreaming biodiversity across government and society (DOC, 2016).

[76] Walker, 2022.

This holistic approach has informed cultural practices within nature for many generations and has led to the development of principles that guide the exercise of authority and care over lands, waters and tribal territories. Connections extend from the practical – such as gathering rongoā, harvesting kai, and collecting resources to make items such as clothes, tools, whare and waka – to cultural aspects – such as engaging with atua and other spiritual beings like taniwha. Being part of nature in such a fundamental way is undermined when culturally meaningful green space is eliminated.

The whakapapa relationship to the land is fundamental in a Māori world. Māori describe themselves generically as tangata whenua, people of the land. The connection with Papatūānuku is one of kinship. In relation to a given place, Māori will also be mana whenua – that is, people who derive their authority from their whakapapa that is rooted in that place. Their pepeha encapsulates the elements of that relationship.

Place-based relationships and responsibilities are embodied through narratives, cultural practice and the maintenance of knowledge.[77] Roles such as kaitiaki and the practice of kaitiakitanga develop from these relationships and further support the obligation that many tangata whenua feel towards their home spaces and the responsibility to care for these places.[78] Separation from nature in urban spaces strikes at the heart of these relationships that are essential for Māori.

From a te ao Māori perspective, biodiversity and mauri are tightly connected. Mauri indicates the life generating and supporting capacity of an entity or space, and relates to the health and wellbeing of the people in it.[79] A forest with a rich variety and abundance of canopy and understory species or wetland will have more mauri than a basic monoculture of grass. A forest is able to sustain much more life, providing a variety of uses and spiritual connections with a place.[80] This holistic view prioritises the network of connections rather than the survival of individual species. Anything that diminishes diversity will cause the mauri of an area to be diminished.

[77] Walker, 2022.
[78] Kawharu, 2000.
[79] Reid, 2021.
[80] McGowan, 2021; Reid, 2021.

Source: Jane Nearing, Flickr

**Figure 1.5: Preparing harakeke at Te Rito o Rotowhio, National Weaving School. Harakeke or flax (Phormium spp) is a taonga species, central to Māori weaving. Different varieties were grown for different purposes such as baskets, medicines or clothing. Many of these varieties were nearly lost through colonisation when pā harakeke were destroyed to make room for urban centres and agriculture. But current trends towards using natural materials from renewable resources, and efforts to maintain Māori weaving arts, practices and knowledge have led to renewed interest and research into different uses for flax.**

For many Māori, urbanisation has led to a disconnection with homelands, knowledge systems, culture, language and identity – so much so that a term is now used to describe urban Māori who do not have direct whakapapa links to the land they live on: mātāwaka. In effect, there are many urban Māori who are not as connected to the land and hence nature as they might wish to be. Providing better access to biodiverse areas of nature in cities can help rebuild these connections and relationships, as can providing access to mara kai and harvestable areas of fibre.[81]

[81] Hutchings, 2015.

## How can green spaces improve biodiversity in New Zealand cities?

Urban green spaces can provide for biodiversity in ways that roads or other paved surfaces and conventional buildings cannot. From a biodiversity perspective, it is important that indigenous ecosystems in urban areas and the necessary connections between them are maintained and, where possible, strengthened by buffering and providing new habitat.

Large green spaces such as town belts and regional parks are crucial hotspots for biodiversity.[82] Beyond these, topography can help. As cities establish, flat, easy-to-develop areas are typically built on first. Steep hills, gullies, coastal cliffs and riverbanks are usually the last areas to be developed, often enabling remnants of native ecosystems to survive in these places.

These remnants can form the backbone of much needed ecological corridors, especially if new areas are developed to create a more coherent network. The green spaces alongside roads and waterbodies (rivers, streams, lakes, coastlines) can form part of an ecological network if they are well designed and maintained. Buildings and landscaping can also contribute through green screens, walls and roofs, swales, and raingardens.

Providing new habitat once it has been removed is not easy. This is particularly so in urban environments where land is at a premium and land use change is inevitable as cities continue to develop and grow. Even if suitable land can be set aside, the range of habitats provided within a healthy remnant native forest cannot be easily or quickly replaced with new plantings. It can take decades or more to regain the complexity and age structure of what was once there.[83] For example, a New Zealand study found that even a 72-year-old regenerating urban forest had still not reached the diversity found within remnants of native forest.[84] A recent study of an urban forest regeneration project in Hamilton found that even early key ecological thresholds (such as canopy closure) can take a decade or more to reach.[85]

Protecting any remnant of an important native ecosystem by avoiding further fragmentation and degradation is clearly an imperative.[86] The ecological value of an existing remnant patch of indigenous habitat is hard to overstate.

Conservation efforts have become increasingly popular in New Zealand cities.[87] Trapping efforts to eliminate introduced predators are now common in many suburbs (many united under the Predator Free 2050 initiative). Many urban restoration initiatives are also working at city (or even regional) scale to create larger ecological corridors by joining together the isolated remnant patches of indigenous cover. These include Auckland's Eastern Bays Songbird Project and North-West Wildlink project, Hamilton's Nature in the City strategy (including its river gully system), Dunedin's Halo Project and Wellington's bush-clad gullies.

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[82] For example, Wellington City Council's district plan states that in terms of ecological significance, "Larger-sized sites are normally more likely to be viable in the long term and to have greater ecosystem or habitat diversity" (Wellington City Council, 2022c, s 18.1.1).

[83] The expansion into greenfield sites usually consumes farmland that can be low in biodiversity. Thus, if new green spaces are carefully designed and created as part of a development, then some new greenfield developments may actually increase urban biodiversity.

[84] Elliot Noe et al., 2022.

[85] Wallace et al., 2022.

[86] Effects should be avoided that reduce the extent and quality of most ecosystems and the habitats of indigenous species, including many highly modified ecosystems and habitats (Walker et al., 2021).

[87] DOC, 2021.

Source: James Reardon

**Figure 1.6: Considerable urban conservation efforts in Wellington now mean that close encounters with kākā are commonplace.**

The biodiversity found in private gardens is clearly important too, not just for the enjoyment of the individual landowner but through what it can offer to the network of biodiversity within a city. There is considerable research on the benefits of backyard biodiversity, including some from here in New Zealand.[88]

## Factors that influence the provision of biophysical benefits from green space

### Below-ground benefits – the fundamental importance of soil for green spaces

Healthy soils are the unseen engine room of any green space. All the biophysical benefits green spaces provide are reliant on healthy soil – particularly shrubs and trees that require large volumes of soil. An adequate volume of healthy soil not only provides water, nutrients and oxygen to a plant but also, importantly, allows the plant's root system to anchor itself, therefore providing the plant with stability.

Despite that, urban soils are under considerable pressure. Most new residential subdivisions begin with earthworks that result in the almost complete removal of topsoil from the area being developed. Roads, footpaths, building foundations and other essential services such as waste and stormwater systems are installed, and then, when building is nearing completion, green spaces are created by adding a veneer of topsoil and planting. Additionally, during development, soils may be heavily compacted to meet engineering requirements.

[88] Stewart et al., 2009; van Heezik et al., 2013.

One practical consequence is that soil volumes on private lots and in the road corridor may be insufficient or too compacted to allow trees to survive and grow to maturity.[89] Promotional illustrations of completed developments are often filled with depictions of large street trees to enhance the imagined environment. In reality, it may take decades for any trees to reach the sizes illustrated, assuming they even survive and manage to grow. Getting from computer simulations to reality can take decades of careful management and cannot be achieved without adequate soil.

A recent monitoring report by Auckland Council highlighted some concerning findings in this regard.[90] The report found that many residential developments had less planting than was shown in the consented landscape plans. There were also issues with the quality of the landscaping that was created, including a lack of provision for trees and planning for maintenance.

Retaining or reinstating an adequate depth and volume of uncompacted soil can be challenging in an urban environment when adjacent built infrastructure can be damaged by roots lifting pavements, cracking roads and foundations, and interfering with pipes and cables.[91]

Challenging, but not insurmountable. Barriers can be installed to channel and contain roots (minimising the chance of them interfering with pipes and cables).[92] Structural soil or systems with supporting elements can be added beneath roads, carparks and permeable pavements to increase the amount of soil available and minimise its compaction.[93] Such approaches can provide support for traffic loads while still allowing more soil for lateral roots and the water retention that large trees require. Some of these approaches are already being used in New Zealand and appear to show promise.[94]

## Green space quality and context matter

In addition to the various benefits of green space already described, it is important to make two further points.

The first is that the *quality* of any green space is critical. Figure 1.7 provides a high-level qualitative assessment of key biophysical benefits for four broad types of green space. The assessment is subjective – it is based on the information provided in this chapter and from wider discussions with various experts. While there will always be some debate about the individual assignments, the overall conclusion is clear. Mown lawns provide fewer and smaller biophysical benefits than more diverse and complex (structured) green spaces (see Box 1.2). A space covered in a variety of shrubs or a wetland will provide more services than lawn grass will. The combined biophysical benefits will be greatest if the area is covered in forest.

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[89] Smiley et al., 2006.

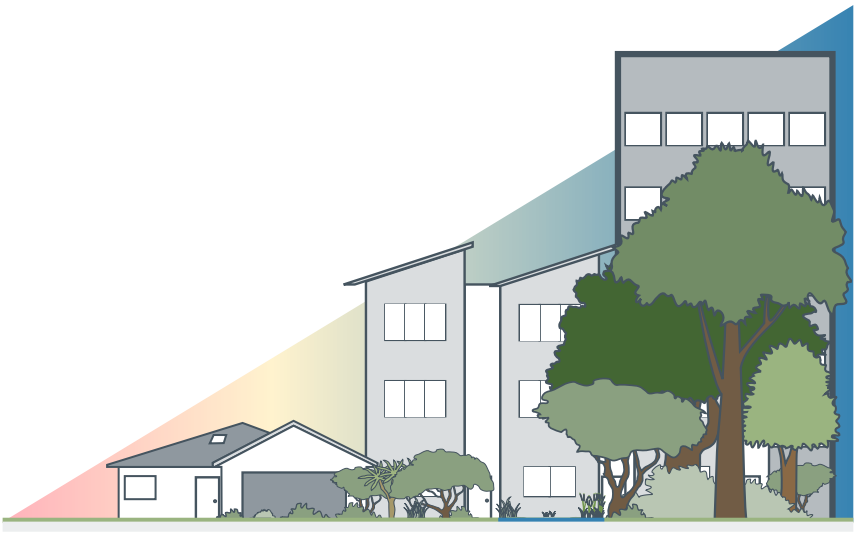
[90] Auckland Council, 2022c.

[91] Watson et al., 2014.

[92] Morgenroth, 2008.

[93] The use of water sensitive design also helps reduce vegetation stress by passively delivering runoff from adjacent impervious surfaces to root systems.

[94] Wynyard Quarter in downtown Auckland employed such devices, and the revamp of George Street in Dunedin that is currently underway is also using them.



| Associated benefits | Types of urban green spaces | | | |
|---|---|---|---|---|
| | Lawn | Low shrubs | Wetlands | Trees |
| Air filtering | Very little | Some | Some | A lot |
| Biodiversity | Very little | Some | A lot | A lot |
| Shading | Very little | Some | Some | A lot |
| Cooling | Some | Some | Some | A lot |
| Stormwater control | Some | Some | A lot | Some |
| Water filtering | Some | Some | A lot | Some |

Source: PCE

**Figure 1.7: The relative benefits of four broad types of green space, assuming each green space type is healthy (i.e. planted in adequate soil and well maintained).**

**Box 1.2: Grass: The least-green green surface?**

Grassed areas are hugely popular in New Zealand, as they are in many parts of the world. Geospatial analysis undertaken for this report suggests they account for half of all green space in Auckland, and perhaps two thirds in Hamilton (see chapter two).

Grass certainly has its place in the urban environment – it is cheap to establish and the carpet-like open space it provides is ideal for sport and recreation. But it comes with environmental limitations.

Grass provides only a relatively meagre suite of environmental services: limited cooling, no shade provision, low diversity and little support for native species. In addition, growing and maintaining grassed areas often makes considerable claims on a range of natural resource inputs.

For a start, grass typically needs to be mown every two to six weeks, resulting in emissions of VOCs and carbon from the machines used. In many cases grassed areas are also treated with chemicals such as fertilisers, pesticides and herbicides, all of which impose an environmental cost when rain carries contaminated runoff elsewhere.

Grass also often requires a lot of water, particularly if a green visual outlook is desired. Frequent mowing leads to high water losses, and hot summer weather can quickly dehydrate the mown plants and dry out the soil. Unless adequate water is provided, water-stressed lawns can brown off and even die, leading to higher surface temperatures, soil damage and dust problems.

The second point is that *context is important*. The geographic location, size, topography and built form of a city will affect the extent to which the various biophysical benefits of urban green spaces are available and desired.

The spatial configuration of green space city-wide is an important component of context. From a biophysical perspective, contiguous areas of green space provide more benefits than smaller isolated ones. But small parks, green walls and private green spaces (including green roofs) can all contribute to a wider network of spaces throughout a suburb or city that are collectively beneficial. Ideally, urban planning should allow for a mix of larger green spaces that are complemented by well-distributed smaller spaces and connected corridors of roadside greenery and vegetated backyards.[95]

[95] Kraemer and Kabisch, 2022.

## Beyond the biophysical benefits of urban green spaces

This chapter focused intentionally on describing the biophysical benefits of urban green spaces primarily because they appear to have received less focus here in New Zealand than some of the wider health, wellbeing, amenity, recreation and cultural benefits that these spaces undoubtedly provide – even if some of these are inherently subjective by nature.

In considering the wider range of benefits green spaces can provide, it is important to remember that different types of green space provide different benefits. For example, a steep bush-clad gully can help regulate water and temperatures, provide for biodiversity and even offer visual amenity, but it may not allow access, and even if it does it will not be suitable for certain activities that a flat open area can provide. Some green spaces may deliver more of one type of benefit and less of another. This is where a better understanding and prescription of the full range of benefits and values desired from urban green spaces can help to deliver a more integrated network of green spaces within the wider urban form. A network of green spaces is also more likely to be more meaningful for those Māori who are seeking the connections between the natural environment, human health and wellbeing that are the essence of a whakapapa-based understanding of the world.

If urban green spaces are to make significant, ongoing contributions to many of the environmental and social challenges cities face, they need to be appropriately planned for, designed, constructed and maintained – and where they already exist, protected.

With this in mind, it may be helpful to think of green spaces as urban *infrastructure* so that they play a more defined role in ensuring legislation and planning frameworks actually deliver the 'quality urban environments' that are often glibly referred to. Cities will be forced to evolve as we adapt to a rising urban population and climate change. Seeing green space as an integral part of emerging urban forms – or not – will have long-lived consequences for the quality of life that urban environments can offer.

# 2

*Parablechnum montanum*

# Urban green space state and trends

Given the services and benefits that green spaces provide, it is important to understand how they are being maintained and added to as urban centres grow. This chapter focuses on quantity: how green our cities are in aggregate, how their green space is distributed spatially and the extent to which the 'greenness' of our cities has changed over the last 80 years. Green spaces provide benefits over potentially very long time horizons, so an equally long view of their evolution is justified.

The existing evidence base provides a fascinating picture of the availability and distribution of urban green space in Aotearoa. The urban tree canopy cover literature, in particular, has emerged rapidly in recent years, with recent assessments now available for Auckland, Wellington City and Christchurch. Other studies have focused on green space more generally (i.e. including areas of grass, scrub and bare ground), mostly using satellite or aerial imagery as a starting point.

But that picture is incomplete for two reasons. Firstly, few of the studies published to date include a temporal dimension. That makes it difficult to assess whether our cities are becoming more or less green as they have grown and changed over time. Secondly, most existing studies focus on one particular type of green space – whether it be trees, publicly owned parks and reserves or the lawns and gardens in residential backyards. We could not find any research that had attempted to assess the full range of green spaces that exist in New Zealand cities, and how they are changing over time.

Research was commissioned for this investigation in an attempt to fill this gap. It assessed how green space – both public and private – in Auckland, Hamilton and Greater Wellington evolved between the early 1940s and the present. These three cities were selected based on a range of factors, including their differing topographic constraints and population growth rates, as well as the availability of suitable aerial imagery. Consideration was given to including Christchurch (as New Zealand's second largest city), but it was ultimately decided that the discontinuity caused by post-earthquake redevelopment would have made comparisons between this city and others difficult to sustain.

The analysis was undertaken by Manaaki Whenua – Landcare Research using a range of automated and manual processes to extract green space from aerial photographs. The analysis was complemented by a survey of public open space acquisitions and disposals in selected other cities since 2016.

Coupled with existing literature, the analysis undertaken for this report provides a more complete picture of the state and trends of urban green space in New Zealand. The following headline messages emerge:

- Auckland, Hamilton and Greater Wellington have expanded considerably over the last 80 years, consuming around 60,000 hectares of previously peri-urban land in the process.[1] In all three cities, the majority of that expansion occurred between 1940 and 1980. Urban expansion since 1980 has been considerably slower.
- Since 1980, population density in Auckland and Hamilton has increased as a result of infill development and, more recently, the increasing popularity of townhouses and apartments. Despite that, average city-wide population densities in Auckland (about 2,500 people per square kilometre), Hamilton and Greater Wellington (both about 2,000 people per square kilometre) are middling by international standards. Cities such as Fukuoka in Japan, Bristol in the United Kingdom and Malaga in Spain – none of them among the densest cities in their respective countries – have average densities in excess of 4,000 people per square kilometre.[2]
- Auckland, Hamilton and Greater Wellington have very different endowments of urban green space. In 2021, 45% of Hamilton's urban area was green space of some kind. The equivalent figure in Greater Wellington was 64%, or 72% if the network of peri-urban reserves is included. That divergence, at least in part, reflects the influence that topography exerts on urban form: vegetation clearance and infill development is much easier on Hamilton's alluvial plain than on Greater Wellington's hillsides. The imagery available for Auckland is older but suggests that 55% of Auckland's urban area was green space in 2011. A separate analysis undertaken by Auckland Council suggests that the equivalent figure was 49% in 2016/17.
- Residential yards and gardens account for slightly more than half of available green space in all three cities. Public parks and reserves represent an additional third, with vegetated berms in the transport corridor making up the remainder. The composition of existing green space is far from consistent across these cities, however. In Hamilton, grass accounts for around two thirds of total green space. That ratio is reversed in Greater Wellington, with woody vegetation accounting for around two thirds of the overall total.
- Auckland and Hamilton have become less green as they have grown over time. Between 1980 and 2016, green space as a proportion of the urban area declined by at least 10–15% in both cities. Those decreases were primarily driven by changes on private residential land – a finding that is consistent with several recent tree canopy cover assessments. Greater Wellington, on the other hand, has managed to maintain pre-existing green space endowments as the city has grown.

[1] That is roughly the size of present-day Auckland.

[2] Demographia, 2022.

- The reduction of private green space in Auckland and Hamilton appears to have been driven by two main trends: ongoing infill development in brownfield areas and a denser built form in large new subdivisions. So-called 'two- (or three-) lot' subdivisions have resulted in the almost wholesale conversion of pre-existing yards and gardens in some suburbs. And a shift towards larger houses on smaller sections – with provision made for multiple car parks – has left little space for the lawns, gardens, shrubs and trees that were synonymous with the 'quarter acre paradise' of a previous era. Those shifts probably reflect a range of underlying factors, including more stringent planning restrictions on urban expansion, worsening transport congestion, increasing urban land prices and, arguably, shifting preferences over the use and extent of backyard space.
- If anything, the reduction of private green space seems to be accelerating. An analysis of post-2016 residential developments in Auckland, Hamilton and Greater Wellington indicates that lawns, gardens and vegetation account for only 20–30% of the area of individual sections – around half of existing city-wide averages. Once implemented, central government's recent direction on urban intensification (particularly via the Medium Density Residential Standards) will further support this trend.
- To date, councils have not been compensating for the reduced size of private yards and gardens through the provision of new public green space. A survey undertaken for this report highlights that a number of councils – including Hamilton City Council, Tauranga City Council and Hutt City Council – have provided no more than a few square metres of new parkland for each additional resident since 2016. In addition, much of what is being provided tends to be of limited size. Auckland, Wellington City and Christchurch are the only cities to have set aside areas of green space larger than ten hectares in recent years, in Christchurch's case partly as a result of the 2011 earthquake rendering significant areas uninhabitable.

The following sections of this chapter summarise the existing literature on the availability of green space and canopy cover in New Zealand cities, the methodology of the empirical analysis undertaken for this report and the results of that analysis.

## What we already know about the availability of green space in our cities

Table 2.1 summarises existing research on the availability and distribution of green space in New Zealand cities. These studies can be divided into two categories: those that focus on mapping tree canopy cover, and those that focus on mapping green space more generally.

The results of urban green space and urban tree canopy cover studies are not directly comparable. Grassed areas such as sports grounds, school fields and residential yards often account for a significant share of a city's urban area but are not typically included in canopy cover studies. That means that the results of tree canopy cover analyses are generally lower than those from analyses that cast a wider net.

Nevertheless, the results of green space and tree canopy cover studies are both valuable, not least because they provide different insights into the various ecosystem services that nature provides. Trees play an important role in providing shade, cooling, carbon sequestration and habitat. Knowing how urban tree coverage is changing is particularly important in these respects. By contrast, when it comes to stormwater management, the area covered by tree canopy is probably less important than whether the ground beneath it is sealed or not. However, neither green space nor canopy cover indicate whether the mauri and biodiversity of the land is thriving.

**Table 2.1: Summary of existing quantitative research on urban nature in New Zealand cities.**

| Study | Location | Study focus | Vegetation differentiation? | Time series? |
|---|---|---|---|---|
| **Mathieu et al. (2007)** | Dunedin | Sections and yards | Yes (× 3) | No |
| **Moore (2017)** | Auckland (5 suburbs) | Sections and yards | No | Yes: 1930 to today |
| **Morgenroth (2017, 2022)** | Christchurch | Tree canopy | N/A | Yes: 2015 and 2018/19 |
| **Lawrence et al. (2018)** | Waitematā | Tree canopy | N/A | No |
| **Blaschke et al. (2019)** | Wellington City (3 suburbs) | Public green (and grey) space | Yes (× 5) | No |
| **Morgenroth (2021)** | Wellington City | Tree canopy | N/A | No |
| **Golubiewski et al. (2021)** | Auckland | Tree canopy | N/A | Yes: 2013 and 2016/18 |
| **Manaaki Whenua (2022) – Land Cover Database** | All New Zealand cities | Green (and grey) space | Yes (× 5) | Yes: 1996–2018 |

## Tree canopy cover studies

Tree canopy cover studies map the area of tree canopy when viewed from an aerial perspective. The methodology involved is generally automated or semi-automated, relying on complex algorithms to classify a combination of Lidar and aerial photographic data into images or maps that distinguish trees from buildings, roads and other green spaces.

At the time of writing, urban tree canopy cover studies have been undertaken in Auckland, Hamilton, Wellington City and Christchurch. As shown in Table 2.2, tree canopy cover varies considerably across New Zealand cities – from 14% in Christchurch to 31% in Wellington City.

Variation in canopy cover is even more marked between individual suburbs. In Wellington City for example, the suburb of Rongotai has almost negligible canopy cover, whereas Highbury has around 70%. Topography can account for some of the difference. The difficulty of undertaking infill development in steeper areas is probably one reason why many of Wellington City's hill suburbs are so densely covered in trees. But the age of the suburb is also likely to be important. Recently established residential areas have had less time for newly planted trees to grow, and current development styles (and legislative settings) make little allowance for the preservation of existing trees, or the planting of new ones.

The tree canopy cover literature also indicates that land ownership is a significant determinant of tree canopy cover. In Auckland, canopy cover in public parks and reserves is 29%, but only 14% on private land.[3] The equivalent figures in Christchurch in 2018/19 were 25% and 11%, respectively.[4] As is discussed further in chapter three, that highlights the challenge of protecting – and providing – trees on privately owned land under the current legislative context.

**Table 2.2: Summary results of recent tree canopy cover studies.[5]**

| City | Author(s) | Study date | Current canopy cover (% of urban area) | Canopy cover variation | Relative change (% for study period) |
|---|---|---|---|---|---|
| **Auckland** | Golubiewski et al. | 2013 and 2016/18 | 18% | 8% (Māngere/ Ōtāhuhu)<br>30% (Kaipatiki) | +1% |
| **Hamilton** | Hamilton City Council | 2019 | 15% | 3.5% (Frankton South)<br>29% (Chedworth) | N/A |
| **Wellington City** | Morgenroth | 2019 | 31% | 1% (Rongotai)<br>71% (Highbury) | N/A |
| **Christchurch** | Morgenroth | 2015 and 2018/19 | 14% | 7% (Hornby)<br>21% (Cashmere) | –10% |

Some tree canopy cover studies also assess changes in canopy cover through time.

In Auckland, Golubiewski et al. found that total canopy cover increased by around 0.6% between 2013 and 2016/18, although they note that this is within the likely margin of error of their analysis.[6] However, changes in canopy cover varied between local board areas – for example, Hibiscus and Bays lost 129 hectares of canopy cover (although some of this was from pine forests being harvested), whereas Manurewa gained 38 hectares.

The authors highlight that the dynamics of canopy cover gains and losses vary:

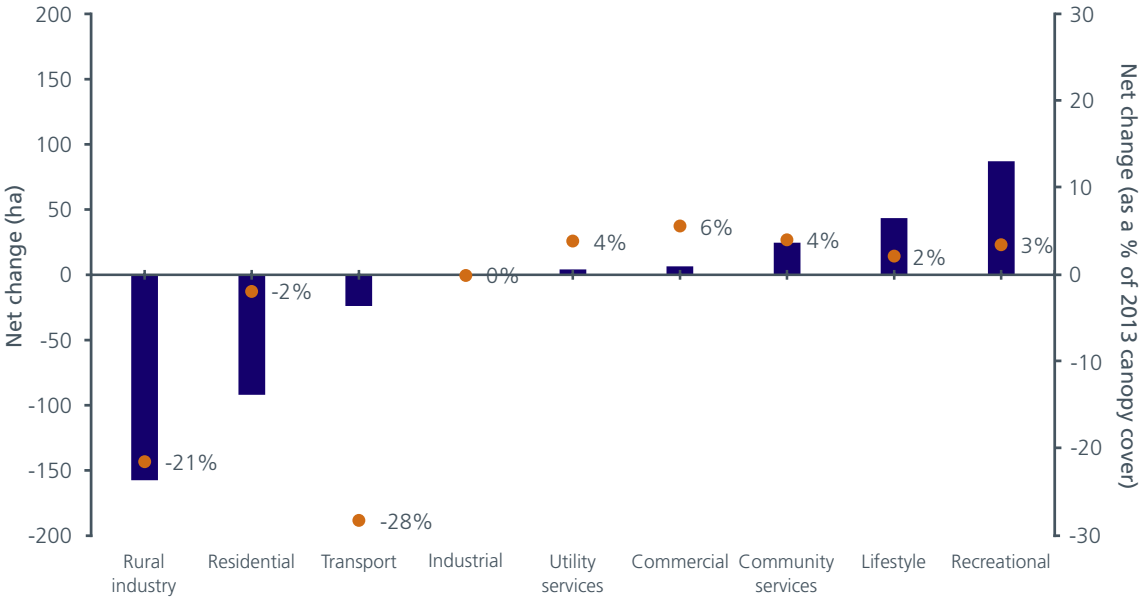
> "Gains in canopy cover largely consisted of … small but ubiquitous instances of tree growth and crown expansion, whereas tree canopy losses were a combination of small, widespread instances (e.g., from maintenance such as pruning and trimming) and discrete events of tree removal".[7]

[3] Golubiewski et al., 2021, p.26.
[4] Morgenroth, 2022, pp.7–8.
[5] Morgenroth, 2017, 2021; Golubiewski et al., 2021; Morgenroth, 2022.
[6] Golubiewski et al., 2021.
[7] Golubiewski et al., 2021, p.iii.

That pattern has resulted in changes to the structure of the tree canopy, with reductions in the area of tree canopy higher than 15 metres and increases below 5 metres in all 16 local boards. This is significant because the services provided by large established trees exceed those provided by small trees and saplings.[8]

The spatial distribution of gains and losses also varies. Golubiewski et al. found that an 87 hectare increase in canopy cover in parks and reserves was more than offset by a 92 hectare decrease on private residential land (Figure 2.1).[9]

A particularly detailed analysis of the Waitematā Local Board area undertaken by Lawrence et al. found a similar pattern.[10] The authors estimated that approximately 13,000 individual "clearance events" resulted in the loss of 61 hectares of tree canopy cover between 2006 and 2016.[11] Tree removal occurred primarily on private land and followed a 'death by a thousand cuts' pattern – 90% of individual clearance events were less than 0.01 hectares in size, but accounted for almost two thirds of the total reduction in tree canopy cover.




Source: Golubiewski et al. (2021)

**Figure 2.1: Distribution of canopy cover gains and losses in Auckland between 2013 and 2016/18.**

[8] Armour et al., 2012.

[9] Golubiewski et al., 2021.

[10] Lawrence et al., 2018.

[11] This represents 17% of tree canopy coverage in 2013. The authors are careful to note that this represents tree losses only, and that some proportion of this will have been offset by tree planting and growth during the same period.

In Christchurch, Morgenroth found that canopy cover decreased between 2015 and 2018/19, although he noted that this should be interpreted cautiously given uncertainties in the analysis.[12] Reductions in canopy cover were largely associated with the harvesting of several peri-urban blocks of plantation forestry, but also took place elsewhere. In road corridors, for example, around 50 hectares of canopy cover (about 11% of 2015 coverage) was lost between 2015 and 2018/19.

The sheer amount of (re)development activity that occurred in Christchurch in the wake of the Canterbury earthquakes makes it a good place to study the effect residential construction can have on tree canopy cover. Guo et al. monitored 6,966 trees on 450 residential properties between 2011 and 2015/16.[13] Of these properties, 321 underwent redevelopment during this period, while 129 did not. The percentage of trees removed on redevelopment sites was 44%, around three times that on other sites.

## Green space studies

Several studies have used aerial photograph or satellite imagery to map the distribution of green space in New Zealand cities. To date, however, this work has tended to focus on one city (or part thereof), one type of green space (e.g. public or private) or one particular time period. That has made it difficult to draw conclusions about how New Zealand cities compare in terms of green space, or how the availability of that green space has changed over time.

### Wellington City

Blaschke et al. used 2013 aerial imagery and a manual classification approach to map public green space in three central city precincts: Thorndon–Tinakori, Lambton and Willis Street–Cambridge Terrace.[14]

The authors distinguished between five types of surface cover: continuous canopy cover; discontinuous canopy cover; bushes, shrubs and horticulture areas; grassed areas; and impervious surfaces. They also distinguished between three types of land tenure: council-owned parks and gardens; public road reserves; and other areas of public green space (e.g. Parliament lawn and Pukeahu National War Memorial Park).

The study area covered 482 hectares, of which 9% was found to be public green space. Around 45% was council-owned parks and gardens, 33% was road reserves, and the remainder was other areas of public green space. In terms of green space type, continuous trees, discontinuous trees and grassed areas each accounted for around a third of the total.

### Dunedin

Mathieu et al. used high-resolution satellite imagery and an automated approach to map green space in Dunedin City.[15] The focus of this study was on private yards and gardens and the urban biodiversity benefits they provide. Three types of vegetation cover were distinguished: dense trees; open trees and shrubs; and open grass.

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[12] Morgenroth, 2022.
[13] Guo et al., 2018.
[14] Blaschke et al., 2019.
[15] Mathieu et al., 2007.

The headline finding from this study was that, in 2005, private residential yards and gardens accounted for 36% of Dunedin City. On average, a yard or garden accounted for 53% of the area of an individual section.

In terms of vegetation, grass was the dominant landcover, making up slightly more than half of the area of residential yards and gardens. Areas of open trees and shrubs accounted for another third of this area, and dense trees for the remainder.

### New Zealand wide: Insights from the Land Cover Database

The Land Cover Database (LCDB) is maintained by Manaaki Whenua and offers a record of how landcover across New Zealand has changed since 1996. While its applicability in urban settings is limited by coarse spatial resolution,[16] the LCDB does provide some insight into how urban open space has evolved over the last two decades.

According to the LCDB, 'urban parkland/open space' in New Zealand cities increased from 39,500 hectares in 1996 to 41,000 hectares in 2018 – an increase of around 4%. During the same period, however, those same cities expanded their footprint by around 15%, consuming 30,000 hectares of undeveloped peri-urban land in the process.[17] In other words, the availability of urban parkland/open space seems to have been increasing, but not as quickly as land on the periphery has been consumed.

## Public green space inventories

Local authorities keep close track of the green space they own or administer, and they regularly publish statistics about it.[18] As discussed further in chapter three, data on current 'levels of service' are often used to inform the appropriate level of public green space provision in new greenfield developments.

Table 2.3 summarises the green space holdings of eight Tier 1 councils. The data suggest there is considerable variability in existing endowments. Hutt City Council, for example, was responsible for managing 2,781 hectares of public green space (which does not include the peri-urban regional parks managed by Greater Wellington Regional Council and others) – 248 square metres per resident. By contrast, Hamilton City Council was responsible for 1,142 hectares, or 65 square metres per resident.

[16] According to Stats NZ (2021d), "The LCDB maps areas of land cover and urban land cover that are at least 1 hectare in size. This means that small urban land cover areas below 1 hectare in size, and the change in these cannot be identified."

[17] Stats NZ, 2021d.

[18] These statistics form the basis for Yardstick, a benchmarking tool operated by Xyst Limited and used to compare parks endowments across cities.

**Table 2.3: Self-reported council green space inventories.[19,20]**

| Council | Year | Public green space (ha) | Public green space (% administrative area) | Public green space ($m^2$/person) |
|---|---|---|---|---|
| **Auckland Council** | 2015 | 13,438 | 2.7% | 87 |
| **Hamilton City Council** | 2020 | 1,142 | 10.3% | 65 |
| **Tauranga City Council** | 2018 | 1,549 | 11.3% | 109 |
| **Upper Hutt City Council** | 2018 | 421 | 0.8% | 93 |
| **Hutt City Council** | 2021 | 2,781 | 7.4% | 248 |
| **Porirua City Council** | 2018 | 998 | 5.7% | 169 |
| **Wellington City Council** | 2021 | 4,146 | 14.3% | 191 |
| **Christchurch City Council** | 2020 | 10,177 | 7.2% | 260 |

The data presented in Table 2.3 are not a perfect measure of the amount of public green space available in New Zealand cities. Two limitations are important to note.

Firstly, not all the green space that is owned or administered by local authorities is located in urban areas (however defined). Local authority administrative boundaries often extend well beyond urban limits, and at least some council-owned green space will be located in rural areas. In that sense, the numbers presented in Table 2.3 are an overestimate of the amount of public urban green space that exists.

Secondly, local authorities are not the only public owners of green space within cities. Regional councils and the Crown (through the Department of Conservation – Te Papa Atawhai, Ministry of Education – Te Tāhuhu o te Mātauranga, and Waka Kotahi NZ Transport Agency, for example) often also have considerable holdings. In Upper Hutt, where the council is responsible for 421 hectares of public green space, there are an additional 34,600 hectares managed by Greater Wellington Regional Council, the Department of Conservation and the Queen Elizabeth the Second National Trust.[21] In that sense the numbers presented in Table 2.3 represent an underestimate of public green space availability.

In addition, the data in Table 2.3 provide little insight into the mix of public green space available in each city. For example, while Lower Hutt, Wellington City and Porirua have relatively large endowments of green space, much of this is in the form of steep bush-clad hillsides. These provide valuable water regulation and habitat functions but are less useful as places for people to meet and socialise close to home.

[19] Public green space data from: Auckland Council, 2015, p.27; Tauranga City Council, 2018, p.235; Hamilton City Council, 2020; Upper Hutt City Council, 2018, p.15; Wellington Regional Leadership Committee, 2022, p.471; Porirua City Council, 2018, p.1; Wellington City Council, 2021a, p.43; Christchurch City Council, pers. comm., 29 November 2022.

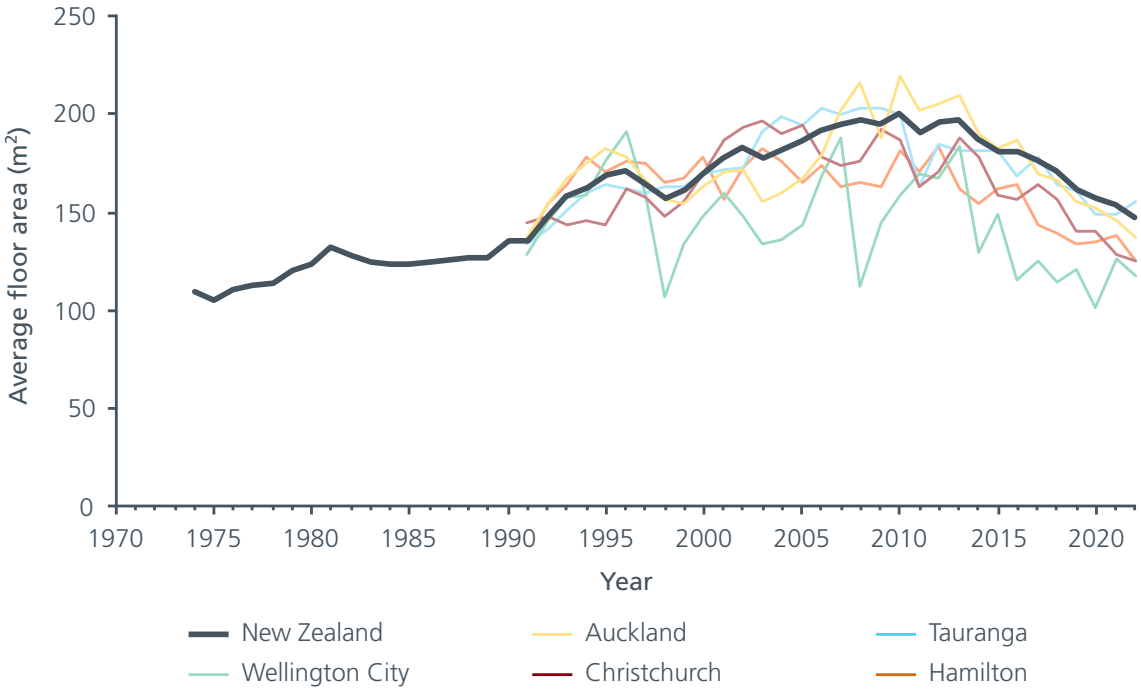
[20] Population data used to calculate per-capita totals from Stats NZ.

[21] Upper Hutt City Council, 2018, p.15.

## Built form and its impact on urban green space

Insights into the availability and distribution of urban green space can also be gained by assessing what is *not* green: buildings (those without green roofs at least), roads, driveways, swimming pools and artificial turf etc. In that respect, data on trends in dwelling footprints and section sizes can give a sense of how private green space is likely to be changing in residential areas.[22]

Figure 2.2 plots building consent data on the size of new residential builds in New Zealand cities over the last 50 years. Most strikingly, the average new build increased from 110 square metres in 1975 to 200 square metres in 2010. New builds have decreased in size since then, partly due to standalone houses becoming smaller and partly due to the increased share of townhouses and apartments being built.[23]




Source: Data from Stats NZ (2022b)

**Figure 2.2: New build sizes, 1974 to today.**

[22] There are two main caveats here. The first is that data on dwelling size relate to total house area – not house footprint. To the extent that dwellings comprise more than one storey, the total built footprint will be overestimated. The second is that not all private green space is necessarily green – a significant proportion is likely to be driveway, patios or other sealed areas.

[23] Stats NZ, 2022b.

While new standalone houses have, until recently, been increasing in size, section sizes have been decreasing. Data compiled by CoreLogic and Te Tūāpapa Kura Kāinga – the Ministry of Housing and Urban Development indicate that the median land parcel size for dwellings built before 2000 was around 700 square metres.[24] The equivalent figure for houses built in 2020 was 451 square metres.[25]

The shift towards smaller sections and, until recently, larger houses has translated into a reduction in the size of private yards and gardens (see Box 2.1 for an Auckland example). On the one hand, that will have had negative consequences for the provision of environmental services in urban areas – stormwater management, habitat, and temperature regulation, for example. On the other hand, a shift to smaller sections and a denser urban form has probably delayed some of the urban expansion – and associated environmental pressures – that would otherwise have happened on the rural periphery.

**Box 2.1: Changes to the built form – and private green space – in Auckland**

A 2017 study used aerial photographs to assess changing development styles in five Auckland suburbs: Point Chevalier, Point England, Papatoetoe, East Tāmaki and Flat Bush.[26] Each suburb was established during a different decade – Point Chevalier being the oldest (1930s) and Flat Bush being the youngest (2010s). This allows conclusions to be drawn about how the residential built form – and yard size – has changed over time.

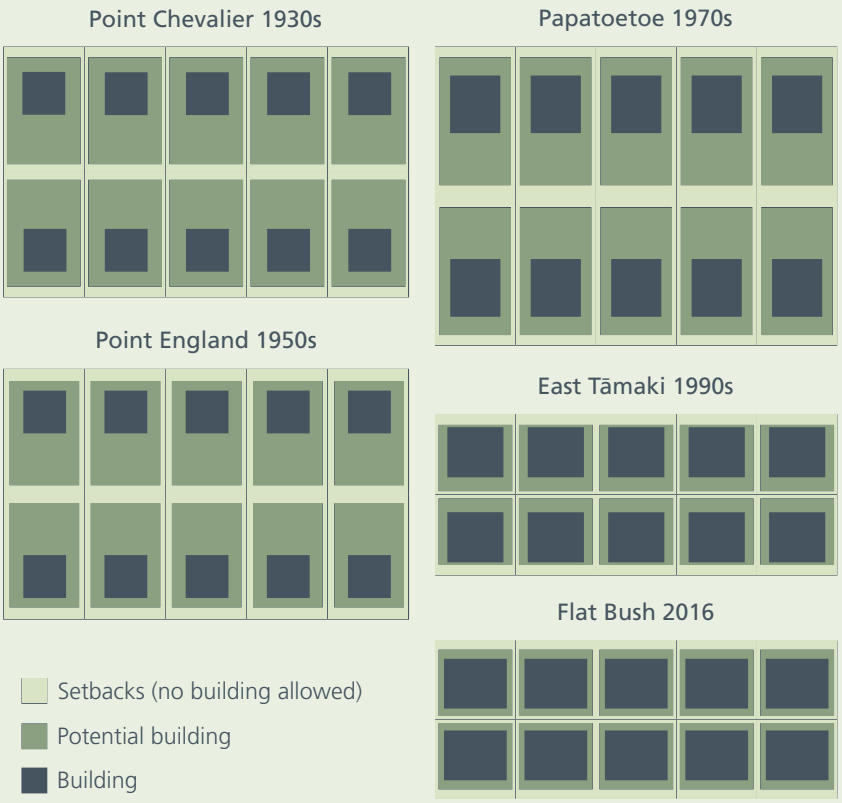
The results in Figure 2.3 are striking. Increasing dwelling footprints coupled with decreasing section sizes have, over time, led to a drastic reduction in the size of residential yards, lawns and gardens.

To illustrate, an average new dwelling in Papatoetoe in the 1970s had a footprint of 190 square metres and was situated on an 800 square metre parcel of land. By the 2010s, emerging suburbs like Flat Bush had dwellings with an average footprint of 210 square metres situated on sections of only 420 square metres. While that still leaves a considerable amount of space for lawns, gardens and trees to be established, in reality, sealed driveways, paths and patio areas are often preferred.

[24] Stats NZ, 2020, p.21.

[25] See also Montgomery, 2015.

[26] Moore, 2018.




Source: Moore (2018)

**Figure 2.3: Changes in development styles in five Auckland suburbs, 1930s to 2016.**

## Empirical analysis undertaken for this report

As part of this report, the Parliamentary Commissioner for the Environment commissioned Manaaki Whenua to undertake an analysis of green space in New Zealand cities. The methodology that was applied involved the use of machine learning processes to extract urban green space from high-resolution aerial photography.

The focus on *urban* green space immediately raises the question of how to define urban areas. Decisions in this regard can have a material effect on the results of urban green space assessments. For the purposes of the analysis undertaken here, a definition based on physical form was used.[27] Essentially, the urban edge was defined by the (visually observable) transition between residential, commercial, and industrial land uses, and their rural equivalents. Space that is 'green' within that urban boundary is counted in this study.

[27] Other definitions of what constitutes an urban area exist. In addition to definitions based on physical form, Stats NZ (2021b) recognises functional or administrative definitions. Functional urban areas, for example, are "based on linkages between where a person lives and where they work, shop, access health care, and recreate – what can be called a person's activity space."

By contrast, land that is green beyond the urban edge – peri-urban land – is excluded from the green space totals presented in this report.[28] That is not to say that privately owned peri-urban green space is unimportant. Depending on its characteristics, it generates many of the same environmental services that urban green space does, particularly for those living at the urban boundary for the time being. But quantifying peri-urban green space is problematic. The area involved depends largely on how far from the urban edge the search radius extends.

Table 2.4 summarises the key parameters of the analysis undertaken in Auckland, Hamilton and Greater Wellington.[29] In each case, three discrete time horizons – 1940s, 1980s and 2010s – were selected. Both public and private green space is included in the analysis, although, as discussed in Appendix 1, this distinction becomes increasingly difficult for earlier time horizons. For the most recent time horizon (where colour imagery is available), a distinction is also made between grass (and bare ground) and all other types of vegetation, like shrubs, trees and forest.

**Table 2.4: Key dimensions of the urban green space analysis undertaken for this report.**

| City | Imagery year (direct detection) | Imagery year (subtraction approach) | Population data |
|---|---|---|---|
| **Auckland** | 2011 | 1942, 1980, 2016 | 1940, 1981, 2013, 2018 |
| **Hamilton** | 2019 | 1943, 1979, 2016 | 1951, 1981, 2013, 2018 |
| **Greater Wellington** | 2021 | 1941, 1980, 2016 | 1951, 1981, 2013, 2018 |

## Methodology

Mapping the distribution of urban green space on the basis of aerial photography is not straightforward.

Even for today, where high-quality colour aerial imagery is available, a number of complicating factors arise. What lies beneath tree canopy cover is one. When viewed from above, tree canopy obscures the ground surface beneath, making it difficult to establish the underlying land cover. Even things as seemingly innocuous as shadows – either from built infrastructure or vegetation – can hinder the accurate classification of urban green space.

The challenge becomes considerably greater for historical periods, principally because of the limitations of black and white imagery. These, by definition, make distinguishing between green and grey space difficult. The issue is most pronounced for surfaces that appear 'flat' (i.e. with little variation in texture) when viewed from above. Areas of tree canopy – with the shadows cast by their foliage – are generally easily discernible from other surface types. By contrast, areas of grass are often difficult to distinguish from concrete, gravel or bare earth.

[28] In contrast, public parks and reserves adjoining the urban area are largely included. Examples include Wellington's Outer Green Belt and Auckland's Long Bay Regional Park.

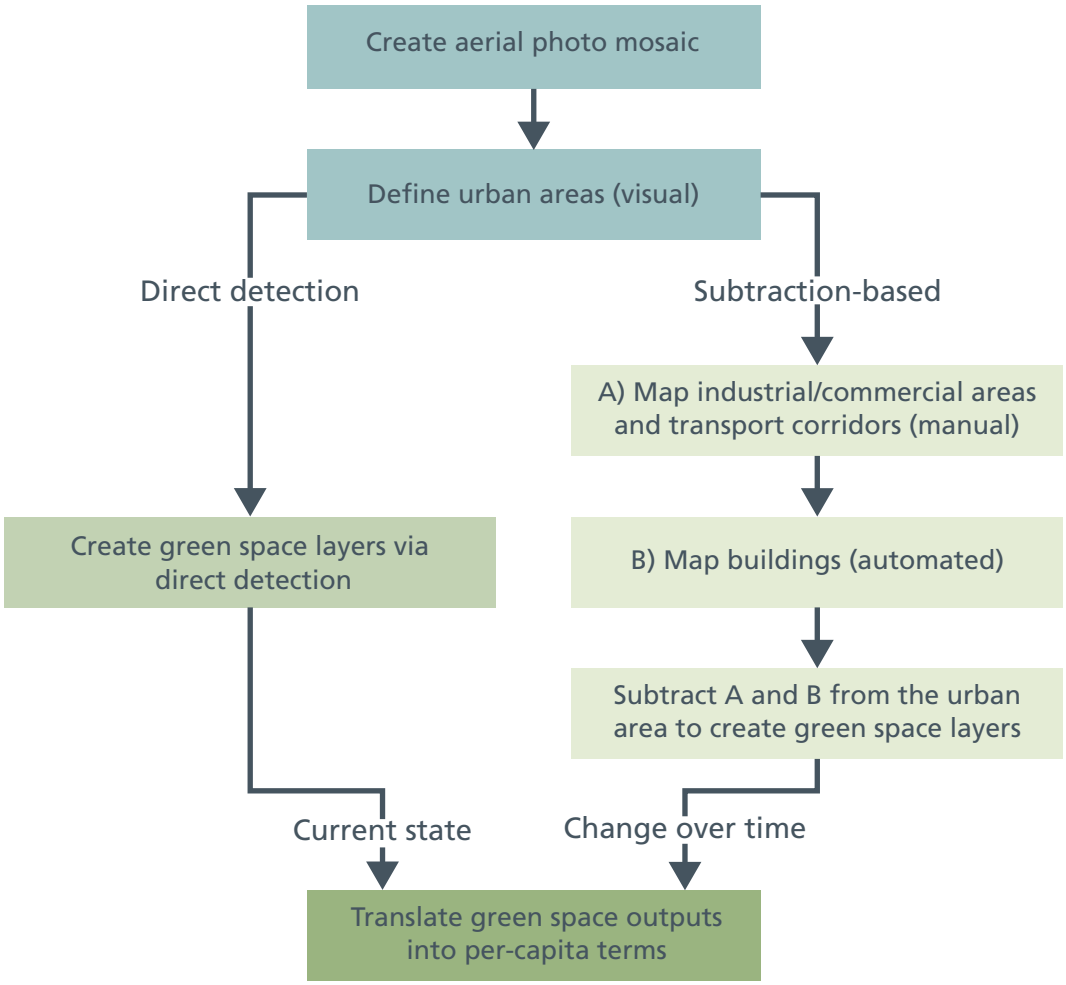
[29] The analysis for Greater Wellington includes the urban areas of Wellington City, Porirua, Lower Hutt, and Upper Hutt.

The methodology originally proposed for the analysis undertaken as part of this report was automated direct detection. The underlying idea was that an appropriately trained machine learning process could *directly* extract areas of green space from both colour and black and white imagery. The time series data generated could then be used to assess how green space availability in New Zealand cities had changed over time.

For the reasons outlined above, it became apparent that such an approach was infeasible for historical periods where only black and white imagery is available. As such, a second parallel methodology – termed the subtraction-based approach – was developed to allow green space trends over time to be constructed. Essentially, this involved identifying – and subtracting from the total urban area – all surface covers that are not green: buildings, transport corridors, commercial and industrial areas, water bodies etc.

Figure 2.4 summarises the two approaches used to map green space. Full methodological descriptions are provided in the Manaaki Whenua reports available on the Office of the Parliamentary Commissioner for the Environment Te Kaitiaki Taiao a Te Whare Pāremata (PCE) website.[30] The appendix to this report sets out the results of the error assessments that were undertaken.

[30] Martin et al., 2022a, b; https://pce.parliament.nz/publications/are-we-building-harder-hotter-cities-the-vital-importance-of-urban-green-spaces/.




Source: PCE

**Figure 2.4: Summary of workflow used to map urban green space: direct detection (left) and subtraction approach (right).**

## Results

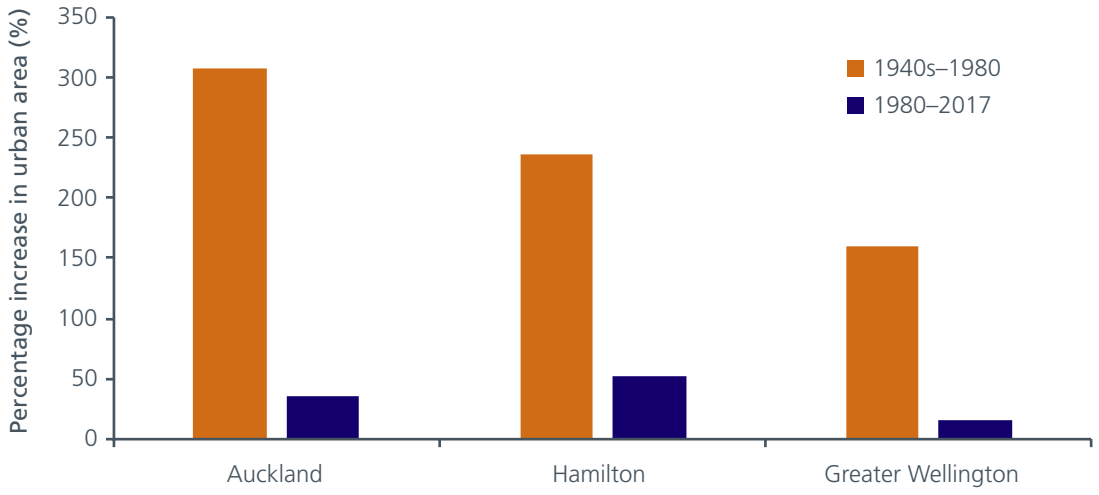
### Urban areas of Auckland, Hamilton and Greater Wellington have expanded dramatically, consuming large quantities of peri-urban land in the process

The urban areas of Auckland, Hamilton and Greater Wellington have expanded significantly since the early 1940s. Auckland and Hamilton have grown the most, their footprints having increased by factors of 5.5 and 5, respectively. Greater Wellington expanded by a factor of 3 during the same period.

This growth has resulted in the conversion of around 60,000 hectares of peri-urban land into new residential, commercial and industrial areas. To put that in context, this is slightly greater than the area of modern-day Auckland. While the analysis undertaken here did not formally assess the type of land that has been consumed, inspection of the underlying imagery suggests the vast majority was previously in pastoral or horticultural use.

Figure 2.5 separates the urban expansion that has taken place over the last 80 years into two periods: the early 1940s to 1980, and 1980 to 2016. The data indicate that urban expansion was considerably more rapid in the post-war period than during the last 40 or so years. That pattern is most obvious in Auckland, where the total urban area expanded by (on average) around 4% year on year between 1942 and 1980, but only around 1% year on year between 1980 and 2016.

That finding is consistent with a number of other studies. Most notably, Xu and Gao used historical planning maps to examine patterns of urban development in Auckland since 1842. They found that "urban sprawl culminated to reach an annual rate of nearly 1,000 ha in the 1960s and 1970s", but only proceeded at a quarter of that rate between 2001 and 2014.[31]




Source: Data from Martin et al. (2022b)

**Figure 2.5: Urban expansion in Auckland, Hamilton and Greater Wellington, early 1940s to 2017.**

Various explanations have been offered for these trends. The widespread adoption of private vehicles and associated public investment in roading networks are often identified as key drivers of post-war urban expansion.[32] The Auckland Harbour Bridge, which opened in 1959, is emblematic of how these forces combined to enable broad areas of peri-urban land to be developed (Auckland's North Shore in this case).

When it comes to the observed slowdown in urban expansion, several related explanations have been put forward. Some studies argue that an increased desire to live in central areas was important. Higher fuel costs (due to the 1970s oil shocks) and growing congestion meant that daily commuting had become less attractive than it was before.[33]

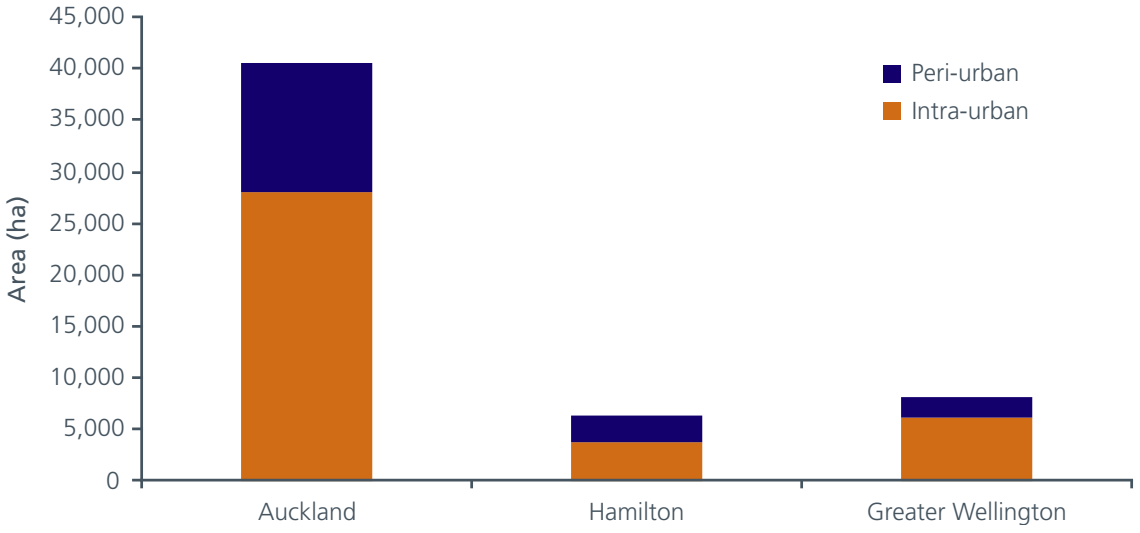
[31] Xu and Gao, 2021.

[32] For example, see New Zealand Infrastructure Commission, 2022, p.26.

[33] A recent analysis undertaken by the New Zealand Infrastructure Commission (2022, p.28) found that "changes in urban travel speeds between the 1970s and 2010s increased demand for housing in inner suburbs that were less affected by rising congestion".

But public policy decisions also appear to have played a role. For councils, the increased cost of infrastructure provision in the more distant parts of cities had become problematic, prompting a greater focus on urban consolidation and intensification.[34,35]

The trend towards development 'inwards' (i.e. via infill development) and 'upwards' has continued in a number of New Zealand's major cities in recent years. Geospatial analysis of cadastral data indicates that about 75% of the residential titles created in Greater Wellington since 2016 were within the pre-existing urban footprint (Figure 2.6).[36] The equivalent figures in Auckland and Hamilton were about 70% and 60%, respectively, although recent building consent data from Auckland suggest the figure has been closer to 80% in recent months.[37] Tauranga appears to be an exception to the rule – building consent data suggest that only around 20% of the dwelling consents granted since 2016 were in the existing urban footprint.[38]




Source: Data from LINZ (2022)

**Figure 2.6: Spatial distribution of residential titles granted after 2016 in Auckland, Hamilton and Greater Wellington.**

[34] Hill, 2008; New Zealand Infrastructure Commission, 2022.

[35] Hill (2008, p.4) notes that the key objective of Auckland's 1988 Regional Planning Scheme was to contain "the growth of the metropolitan area by defining the metropolitan limits, and managing urban expansion within these limits".

[36] PCE analysis of Toitū Te Whenua – Land Information New Zealand (LINZ) data. Residential titles were defined as being less than 1,000 $m^2$ in size. Titles within 250 m of the urban boundary – or less than 1,000 m beyond it – were defined as peri-urban.

[37] Auckland Council, 2022a, p.7.

[38] SmartGrowth, 2021a, p.75.

## Auckland and Hamilton have become more densely populated since 1980

In 2018, Auckland had an average city-wide population density of approximately 2,500 people per square kilometre. Greater Wellington and Hamilton were less densely inhabited, with average densities of about 2,100 and 2,000 people per square kilometre, respectively.[39]

Within each city, population density varies considerably. As shown in Figure 2.7, city blocks with densities ranging between 2,000 and 4,000 people per square kilometre are particularly common. These tend to be dominated by the standalone houses that have been so popular throughout New Zealand's history. At the other end of the spectrum, some city blocks have population densities exceeding 10,000 people per square kilometre. These are typically inner-city areas where multilevel apartment buildings are present.

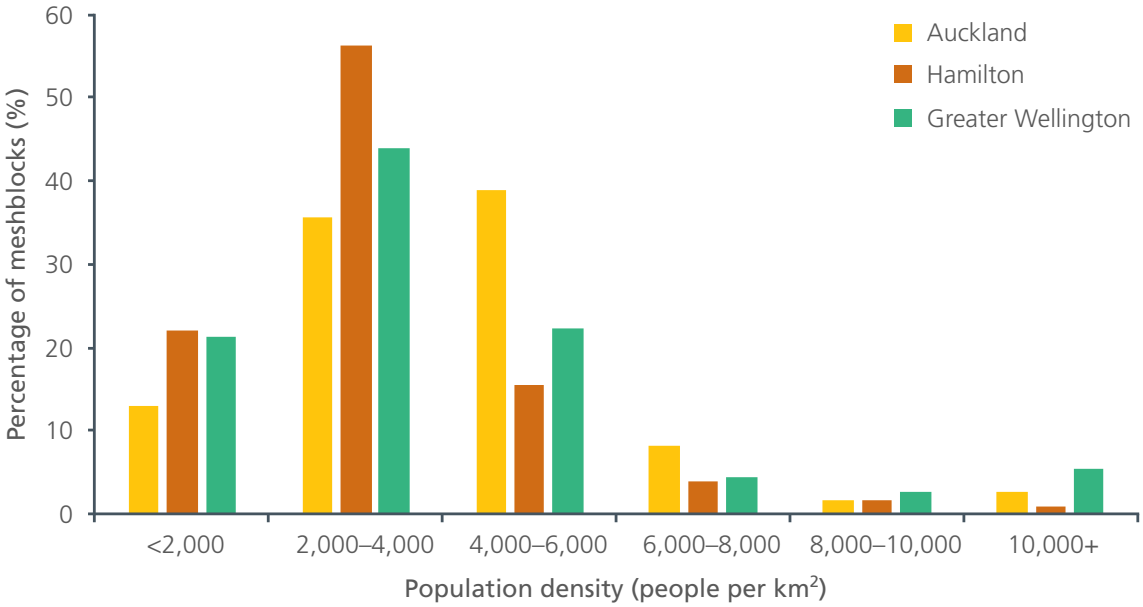
Medium-density typologies – terraced houses, duplexes, townhouses – represent something of a middle ground and one that has become increasingly popular in recent years. In Auckland, for example, the share of townhouses and units in all new residential builds increased from 15% in 2009 to 55% in 2022.[40] Population density in areas with significant amounts of terraced housing (e.g. Hobsonville or Takanini in Auckland) tends to be in the order of 6,000 to 8,000 people per square kilometre.

In the context of this report, it is worth noting that medium-density development does not necessarily include more private green space than multi-storey apartment buildings. At the same time, medium-density housing results in fewer dwellings per unit of land area than apartment buildings. That raises a question as to whether an increased share of development 'upwards' could help increase housing supply but place less pressure on existing private green space as a side effect. Between January 2019 and September 2022, apartments represented less than 10% of all new residential building consents in many of our cities (including Hamilton, Tauranga, Porirua, Upper Hutt, Lower Hutt and Christchurch).[41]

[39] These city-wide population density figures include large uninhabited areas (e.g. industrial zones, commercial areas, open space) and are therefore considerably lower than the figures cited in the following paragraph (which are largely specific to residential areas).

[40] Stats NZ, 2022b.

[41] Stats NZ, 2022b.



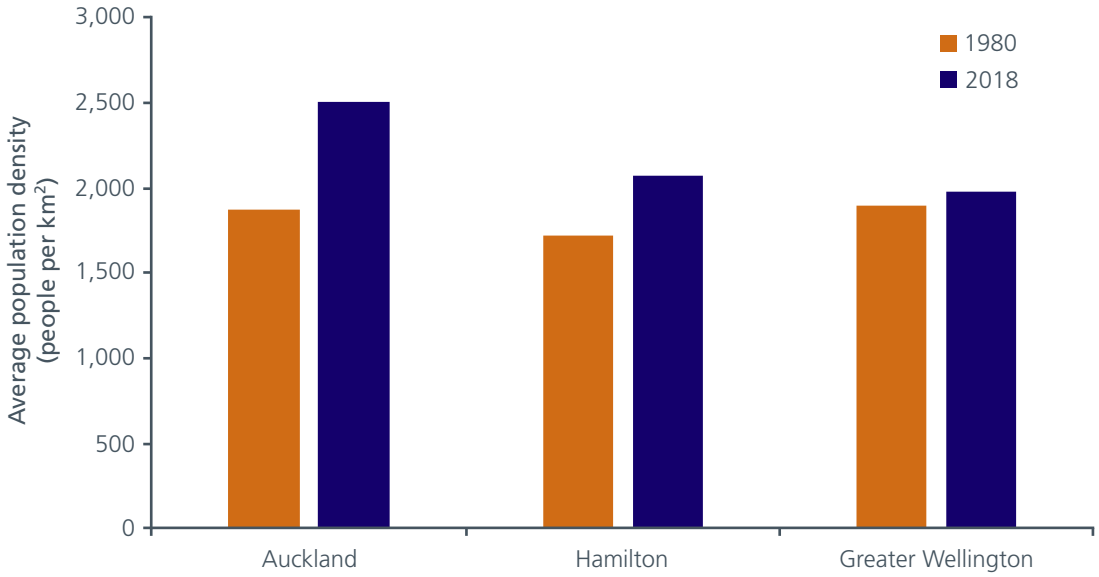

Source: Data from Stats NZ (2022a)

**Figure 2.7: Distribution of population density by 2018 Census meshblock in Auckland, Hamilton and Greater Wellington.**

Since 1981, the rate of population growth in Auckland and Hamilton has exceeded the rate of urban expansion by some margin, with considerable densification having occurred as a result (Figure 2.8). Average city-wide population density in Auckland has increased by around 30% since 1981, and by roughly 20% in Hamilton. Hoffman and Xu and Gao document similar trends, with population density in Auckland having increased consistently since the mid-1980s.[42]

Greater Wellington has developed differently. For one thing, the city-wide population only increased by around 20% between 1981 and 2018 (vis-à-vis 80% in Auckland and Hamilton). Furthermore, that increase in population has occurred at roughly the same rate as the urban area has expanded, with city-wide average population density having only increased slightly as a result. That suggests that increased population density resulting from intensification within the pre-existing urban footprint has been largely offset by low-density development on the periphery.

[42] Hoffman, 2019; Xu and Gao, 2021.




Source: Data from Martin et al. (2022b)

**Figure 2.8: Change in city-wide population density in the urban areas of Auckland, Hamilton and Greater Wellington, 1980 and 2018.**

The observed increase in population density in Auckland and Hamilton reflects several decades of infill development and intensification. The focus on intensification continues to the present day.

In Auckland, the Unitary Plan contains an objective that "urban growth is primarily accommodated within the urban area 2016".[43] That objective is clearly visible in Auckland's zoning provisions. As of March 2022, around 8% of Auckland's residential area was zoned for terrace housing and apartment building.[44] That figure increases to 85% if the mixed housing suburban and mixed housing urban zones – which both allow for up to three dwellings on an individual site as a permitted activity – are included.

In Hamilton, the recently adopted *Future Proof Strategy* contains a goal that "at least 50 per cent of growth will be through regeneration of existing parts of the city."[45,46] As of March 2022, Hamilton's residential intensification zone, which is intended to "encourage site redevelopment, primarily for multilevel and attached housing", accounts for roughly 6% of all residentially zoned areas.[47] Significantly though, the general residential zone, which as of March 2022 accounted for roughly 87% of residential areas, allows for duplex-style development as a restricted discretionary activity.

Those zoning provisions are clearly translating into development outcomes. Figure 2.9 shows the new residential titles that have been created in selected parts of Auckland and Hamilton since 2016.

[43] Auckland Council, 2022b, chapter B2, p.2.

[44] PCE analysis.

[45] Future Proof, 2022a, p.7.

[46] More recently, the *Draft Hamilton Urban Growth Strategy* proposes increasing that number to 70% (Hamilton City Council, 2022b).

[47] PCE analysis.


Source: Data from LINZ (2022)[48]

**Figure 2.9: Subdivision and infill development in Papatoetoe, Auckland (top), and Enderley, Hamilton (bottom), 2016–2022.**

Zoning permissiveness in all major New Zealand cities is set to increase dramatically as intensification provisions contained in the National Policy Statement on Urban Development and the Resource Management (Enabling Housing Supply and Other Matters) Amendment Act 2021 are given effect to. These changes are discussed in detail in chapter three but will, in short, require Tier 1 councils to allow for medium-density housing in most residential areas, and multi-storey apartment buildings in city centre zones and along transport corridors.

[48] Aerial imagery sourced from the LINZ Data Service and licensed by Auckland Council and AAM NZ Limited (Papatoetoe imagery) and Hamilton City Council (Enderley imagery) for reuse under CC BY 4.0.

## Auckland, Hamilton and Greater Wellington are well endowed with green space, but some suburbs are much better served than others

The direct detection analysis undertaken for this report indicates that combined public and private green space currently accounts for 45% and 65% of the urban areas of Hamilton and Greater Wellington, respectively (Figure 2.10). The equivalent figure in Auckland (55%) dates from 2011. Ongoing urban intensification means the figure today is likely to be considerably lower. An analysis of land-use data provided by Auckland Council indicates that green space accounted for 47% of the urban area in 2016/17.[49]

In Auckland and Hamilton, slightly more than half of that green space is privately owned – mostly in the form of lawns and gardens on individual residential sections. The remainder is accounted for by public green space (e.g. parks, sports fields, natural areas, golf courses, school grounds etc) or vegetated berms in the road corridor.

Greater Wellington is particularly well endowed with public green space, which alone accounts for around 24% of the total urban area. That figure increases to 41% when Greater Wellington's extensive network of peri-urban reserves is included. It would be significantly higher again if the area contained in regional parks were counted.[50] Much of that peri-urban green space is far from where people live, however. And little of it provides the easily accessible social and recreational functions that local and neighbourhood parks do.


Source: Data from Martin et al. (2022a)

**Figure 2.10: Green space as a share of urban area: Auckland (2011), Hamilton (2021) and Greater Wellington (2021).**

[49] These data are a result of an aerial photographic analysis similar to that undertaken for this report.

[50] There are eight such parks: Akatarawa Forest, Battle Hill Farm Forest Park, Belmont Regional Park, Queen Elizabeth Park, East Harbour Regional Park, Kaitoke Regional Park, Pakuratahi Forest, and Wainuiomata Recreation Area. According to Greater Wellington Regional Council (2020), these parks cover 33,000 hectares (relative to the 8,300 hectares of public urban and peri-urban green space that were mapped as part of the analysis undertaken here).

In practice, urban green space availability in New Zealand is often expressed in per-capita terms. On that basis, residents of Auckland, Hamilton and Greater Wellington enjoy roughly 240 square metres, 220 square metres and 330–470 square metres of green space, respectively (Figure 2.11).


Source: Data from Martin et al. (2022a)

**Figure 2.11: Green space per capita: Auckland (2011), Hamilton (2021) and Greater Wellington (2021).**

Current green space endowments vary considerably in terms of the composition of their vegetation. In Hamilton, grass accounts for around two thirds of the city's overall green space, with various kinds of woody vegetation making up the remaining third. That ratio is reversed in Greater Wellington, with woody vegetation accounting for around two thirds of overall green space.[51]

Topography probably exerts a considerable influence on differences in green space composition across cities – it is simply much more difficult to mow or remove vegetation on Greater Wellington's hillsides than on Hamilton's alluvial plain. The role that topography plays can also be seen within individual cities. Figure 2.12 shows the distribution of grass (light green) and woody vegetation (dark green) in an area of northeast Hamilton, with the latter largely restricted to the gully system on the right of the images.

[51] In Auckland, the ratio between grass and woody vegetation is more evenly balanced, with grass accounting for slightly more than half of overall green space.


Source: Data from Martin et al. (2022b)[52]

**Figure 2.12: Distribution of grass and woody vegetation in Rototuna, northeast Hamilton.**

The city-wide green space endowments shown in Figures 2.11 and 2.12 are not evenly distributed across our cities. In Auckland and Hamilton, people living in the greenest 25% of suburbs enjoy around three times as much public green space as people in the least green 25% of suburbs.[53] That disparity is even more pronounced in Greater Wellington due to the extensive network of parks and reserves adjacent to some of the hillier peri-urban parts of the city.

Interestingly though, there is no obvious relationship between the green space endowment of individual suburbs and the relative affluence of their residents. That result holds regardless of whether affluence is measured in terms of median income (see Figure 2.13) or a measure of socio-economic deprivation.[54]

The lack of any obvious correlation between green space endowment and socio-economic status contrasts with other (tree canopy cover based) assessments, which have concluded that less affluent suburbs tend to have less tree canopy cover.[55,56] Reconciling those results is not straightforward, although it is possible that there is some truth to both findings. Less affluent suburbs do have less tree canopy cover, but not necessarily an overall shortage of green space. Certainly, the urban fabric in parts of south Auckland and Porirua includes sizeable private yards and road berms, although these tend to be covered with grass.

Māori represent a significant proportion of the population of both those areas. As discussed in chapter one, lack of access to natural areas denies urban Māori opportunities to connect to and undertake cultural practices like collecting rongoā or kai, which require travel to distant reserves in periphery areas.[57]

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[52] Aerial imagery sourced from the LINZ Data Service and licensed by Hamilton City Council for reuse under CC BY 4.0.

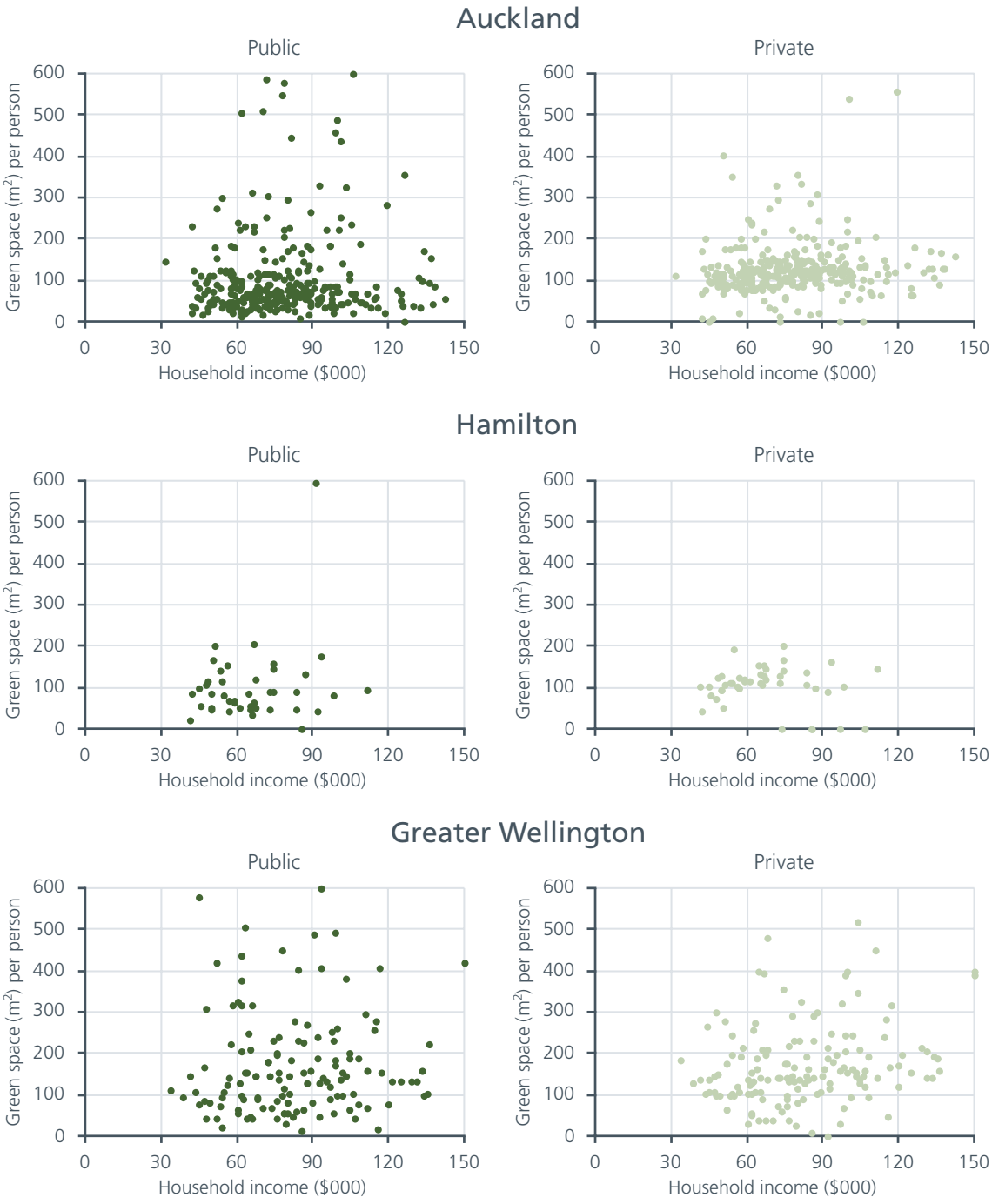
[53] PCE analysis undertaken at the 2017 statistical area unit level. The boundaries of statistical area units often coincide with the margins of larger parks. For the purposes of this analysis, that means that a suburb bordering on a large park may appear to have little public green space, with the disparity in green space availability overestimated as a result.

[54] Such as the New Zealand Deprivation Index (University of Otago, 2021).

[55] Whitburn, 2014; Latif, 2022; Newton, 2022.

[56] Whitburn (2014) studied the relationship between socio-economic status and the level of planting in 20 Wellington suburbs. She concluded that there is "inequity in the richness of vegetation in neighbourhoods across Wellington City which was associated with socio-economic differences" (p.169).

[57] Walker, 2022.




Source: Data from Stats NZ (2014) and Martin et al. (2022a)

**Figure 2.13: Public (left) and private (right) green space versus median household income in individual Auckland (top), Hamilton (middle) and Greater Wellington (bottom) suburbs.[58]**

[58] At the 2017 statistical area unit level.

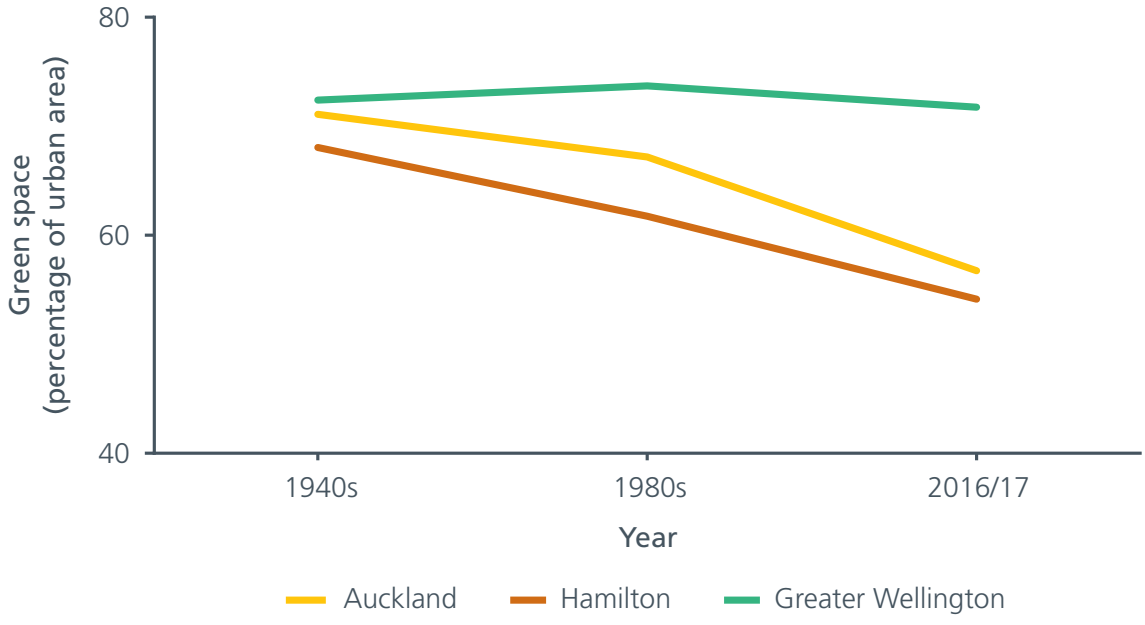
## Auckland and Hamilton have become less green over time

Auckland and Hamilton have become less green as they have grown (Figure 2.14).

The subtraction approach used to estimate how green space has changed through time indicates that in the early 1940s, around 70% of the urban areas of both cities were green space of one kind or other. By 2016, that figure had declined by around 15 percentage points in both cities, although that is very likely an underestimate owing to problems identifying driveways, carparks and other sealed areas.[59] An error assessment indicates that the actual magnitude of the reduction could feasibly be 10 percentage points higher (see Appendix 1).

As shown in Figure 2.14, the reduction of green space in Auckland appears to have been most rapid between the 1980s and today. That perhaps owes something to the shift away from growth 'outwards' that occurred in the 1980s. An increased emphasis on development within the existing urban footprint probably led to infill development and the consumption of green space in pre-existing yards and gardens.

The picture is different in Greater Wellington: green space as a proportion of the urban area has remained essentially constant over the last 80 years, and even increased slightly if the network of peri-urban reserves is accounted for.




Source: Data from Martin et al. (2022b)

**Figure 2.14: Evolution of urban green space in Auckland, Hamilton and Greater Wellington, 1940s to 2016/17.**

[59] Driveways, carparks and other sealed features (e.g. patios and swimming pools) have become more widespread through time. In general, the subtraction-based approach does not capture these features, and so will tend to overestimate green space more in relatively recent periods.

The observed decrease in green space in Auckland and Hamilton appears to have resulted mostly from changes on private residential land. While there is considerable uncertainty involved, the subtraction-based analysis suggests that private green space as a proportion of Auckland's urban area fell by 20% between 1980 and 2016. The equivalent figure in Hamilton was around 15%. The two key drivers of that reduction – infill development and a change in the dominant development typologies – are discussed in detail in the next section.

By contrast, public green space as a proportion of the land within the urban boundaries of Auckland and Hamilton seems to have remained steady – at around 15–20% since the 1940s. The same is true in Greater Wellington, although the proportion is considerably higher (at about 40% if peri-urban reserves are accounted for). Over the long term, these results indicate that councils have been able to set aside new areas of public green space at a rate that broadly matches the rate of urban expansion – if not the rate of population growth.[60]

That is not to say that no public green space has been lost. In each of the three cities assessed here, there are examples of historical parks and reserves that have been disposed of for residential or industrial development. And, as discussed in detail in chapter three, that process has continued in recent years. Auckland Council has recently undertaken a reserve 'rationalisation' process to help address fiscal stresses created by the Covid-19 pandemic.[61] Similarly, as of December 2022, Tauranga City Council was consulting on proposals to develop reserve land.[62]

To get a better understanding of how widespread parks disposal has been in very recent times, a selection of Tier 1 councils were asked to provide data on the acquisition and disposal of undeveloped land since 2016.[63] Tables 2.5 and 2.6 summarise the findings from that survey.

[60] In Auckland, for example, public green space per capita fell by around 20% between 1980 and 2016. The equivalent figure in Hamilton is ~10%.

[61] See, for example, Auckland Council, 2022g.

[62] Tauranga City Council, 2022b.

[63] Councils were asked to include "transactions involving open space that is (or was) explicitly managed as a park or reserve, as well as transactions involving other types of open space".

**Table 2.5: Acquisition of land for new public green space, 2016–2021.[64,65]**

| Council | Number of transactions | Area acquired (ha) | Median parcel size (ha) | Acquisi-tions > 10 ha | Area acquired ($m^2$ per new resident) | Existing endowment ($m^2$ per resident) |
|---|---|---|---|---|---|---|
| Auckland Council | 110 | 300.4 | 0.40 | 5 | 24 | 87 |
| Hamilton City Council | 26 | 8.2 | 0.43 | 0 | 5 | 65 |
| Tauranga City Council | 22 | 4.4 | 0.07 | 0 | 2 | 109 |
| Upper Hutt City Council | 2 | 7.7 | – | 0 | 21 | 93 |
| Hutt City Council | 1 | 2.2 | – | 0 | 3 | 248 |
| Porirua City Council | 37 | 24.3 | 0.12 | 0 | 48 | 169 |
| Wellington City Council | 11 | 103.9 | 3.3 | 2 | 94 | 191 |
| Christchurch City Council | 417 | 622 | 0.14 | 13 | 355 | 260 |

**Table 2.6: Disposal of public green space, 2016–2021.**

| Council | Number of transactions | Area disposed (ha) | Median parcel size (ha) | Disposals > 10 ha |
|---|---|---|---|---|
| Auckland Council | 39 | 13.6 | 0.1 | 0 |
| Hamilton City Council | 0 | – | – | – |
| Tauranga City Council | 0 | – | – | – |
| Upper Hutt City Council | 0 | – | – | – |
| Hutt City Council | 3 | 1.8 | 0.75 | 0 |
| Porirua City Council | 7 | 0.85 | 0.1 | 0 |
| Wellington City Council | 4 | 0.64 | 0.164 | 0 |
| Christchurch City Council | 6 | 8.01 | 0.12 | 0 |

[64] Data on area acquired per new resident is based on survey responses together with population data from Stats NZ.

[65] Data on existing endowments from self-reported council green space inventories (see 'Public green space inventories' section above).

Since 2016, the balance between open space acquisitions and disposals has been overwhelmingly in favour of acquisitions. Auckland Council is the only council to have disposed of material amounts of public open space, but these disposals have been easily offset by the amount of land acquired for new open space. A number of councils – including Tauranga City Council, Hamilton City Council and Upper Hutt City Council – have not disposed of a single park or reserve in the last five years.

That said, based on the information contained in Table 2.5, it is difficult to conclude that the provision of new parks and reserves has been keeping pace with population growth. While open space acquisition can be 'lumpy', some councils only appear to have provided a few additional square metres for each new resident since 2016.[66] As shown in Table 2.5, that represents a very small fraction of pre-existing endowments. If recent provision levels persist, the availability of public green space per capita will continue to decline as our cities grow.

## Infill development and a change in development styles have led to a reduction in private green space

As noted, the observed reduction in city-wide green space in Auckland and Hamilton has occurred largely on privately owned land. Two main trends appear to have played a role: infill development and a shift towards larger houses on smaller sections. The underlying drivers of those trends probably include the introduction of more stringent limits on growth 'outwards', worsening transport congestion, and the increase in urban land prices that has emerged as a result. Shifting preferences for backyard space may also have played a role. The now oft-heard desire for low maintenance 'lock-up and leave' properties is, anecdotally at least, not something that was widely heard in the 1950s and 1960s.

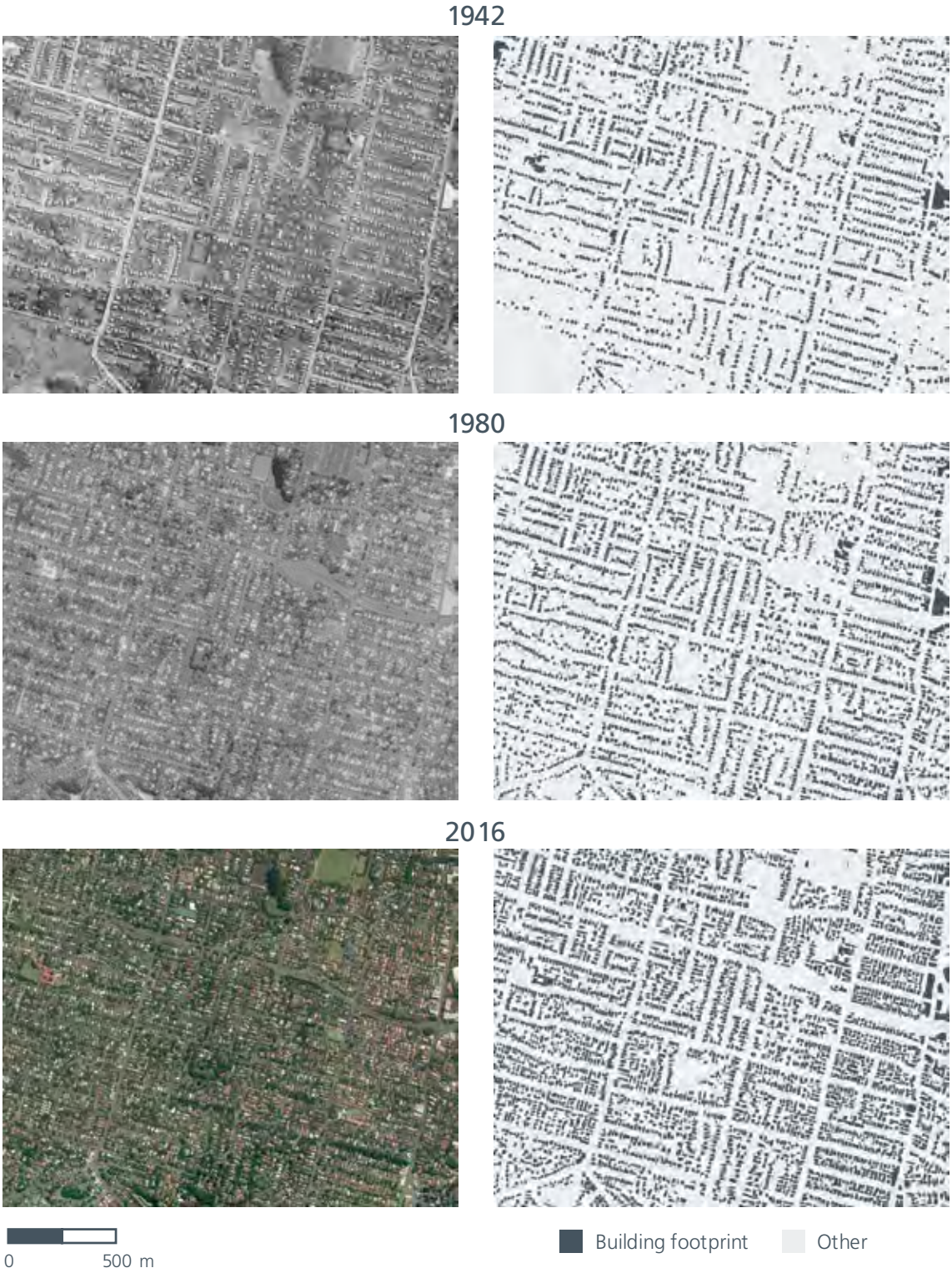
The first trend – infill development of existing residential areas – has been commonplace where zoning rules have permitted it, and has resulted in the widespread conversion of pre-existing yards and gardens into new dwellings and driveways. Figures 2.15 and 2.16 illustrate the magnitude of the change in built form that has occurred in Hamilton East and Epsom, Auckland.

[66] Christchurch represents an exception, although this is probably at least partly due to changing land ownership in the wake of the Christchurch earthquakes.


Source: Data from Martin et al. (2022a)[67]

**Figure 2.15: Infill development in Hamilton East: 1943 (top), 1979 (middle) and 2016 (bottom). Dark grey areas in the right panels represent building footprints.**

[67] Aerial imagery sourced from the LINZ Data Service and licensed by Auckland Council and AAM NZ Limited for reuse under CC BY 4.0.




Source: Data from Martin et al. (2022a)[68]

**Figure 2.16: Infill development in Epsom, Auckland: 1942 (top), 1980 (middle) and 2016 (bottom). Dark grey areas in the right panels represent building footprints.**

[68] Aerial Imagery sourced from the LINZ Data Service and licensed by Hamilton City Council for reuse under CC BY 4.0.

The second trend – larger houses on smaller sections in new residential developments – has also contributed to the observed decrease in private green space.

As discussed, building consent data indicate that the average size of a new dwelling almost doubled between 1975 and 2010. At the same time, sections became smaller with less space for yards, gardens, trees and vegetation as a result. This reduction in the size of privately owned green space has likely been exacerbated by the emergence of 'two-car families' and planning rules that, until recently, have required off-street garaging and car parking.[69]

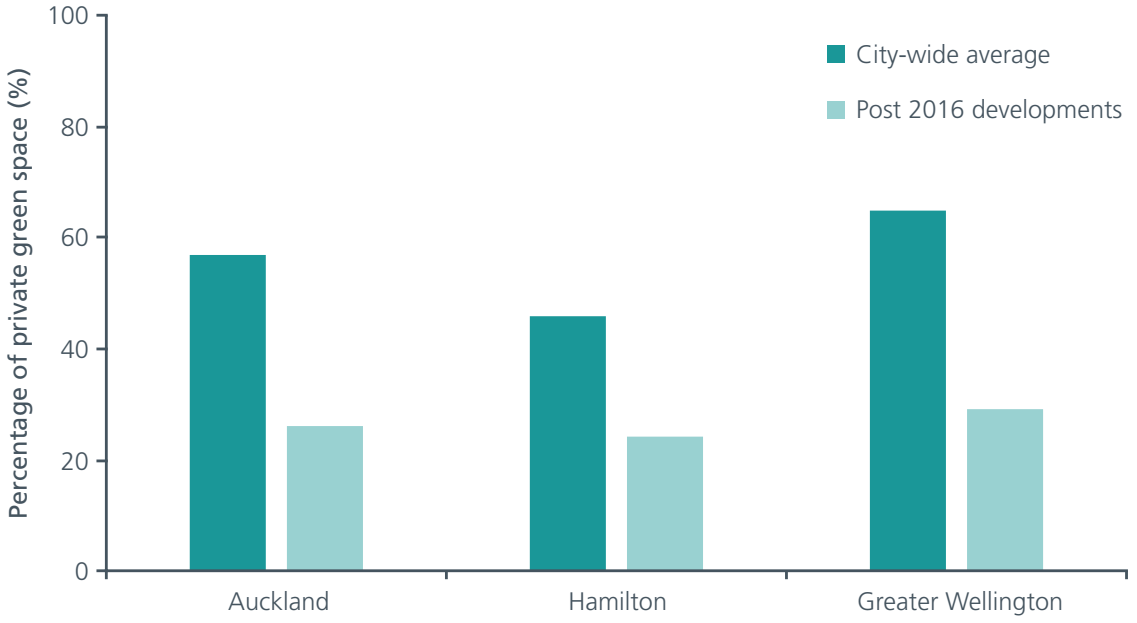
To get a better sense of how the fabric of new residential development has changed, results from the 2021 direct detection analyses of Hamilton and Greater Wellington were segmented for post-2016 development areas.[70] In Auckland – where the direct detection results date from 2011 – outputs from the manual digitisation of more recent imagery were used.[71] Comparing the results of these exercises with those at the aggregate city level provides a fascinating insight into how the style of residential development in New Zealand has changed.

On average, green space accounts for between roughly 50% and 60% of the area of private residential land across the entirety of Auckland, Hamilton and Greater Wellington (Figure 2.17). That endowment represents the interaction between planning rules and private landowner decisions since the very early emergence of each city. It contrasts strikingly with the green space provided in the most recent developments which, on average, amounts to around 20–30% of individual sections.

[69] The National Policy Statement on Urban Development recently required councils to remove minimum car parking rules from their district plans.

[70] On the basis of titles data from Stats NZ.

[71] Sampling was undertaken in Long Bay, Hobsonville Point, Flat Bush, Takanini and Drury.




Source: Data from Martin et al. (2022a) and LINZ (2022)

**Figure 2.17: Green space as a proportion of private residential land: city-wide averages versus post-2016 developments.**

Visual assessment of several representative 'built forms' in Auckland provides additional insight into the changing character of residential development. Figure 2.18 compares the residential fabric created during two periods of the city's history – early twentieth century standalone housing (Westmere) and post–World War Two state housing (Mount Roskill) – with that being created today – standalone housing (Long Bay) and terraced housing (Hobsonville). Each of the images are presented at the same scale to allow for comparison.

Again, the headline message is that recent residential development makes relatively little provision for private yards and gardens – particularly where terraced housing is involved. That is in significant part due to the smaller size of sections that are being created.[72] But, it also reflects the increasing tendency to seal unbuilt land to allow for vehicle access and storage.

Interestingly, the built form of suburbs being created today is not altogether different to that created during the early part of the twentieth century. Westmere in Auckland and a number of other inner-city suburbs feature rows of houses built closely together on relatively small sections. Similar typologies are visible in Wellington's inner-city suburbs of Mount Victoria, Te Aro and Newtown. A key difference, of course, is that residents of central Auckland and Wellington benefit from the existence of a number of large public parks and reserves – something that is not always the case in areas being developed today.

[72] Average section sizes in the parts of Westmere and Mount Roskill shown are ~430 $m^2$ and ~650 $m^2$ respectively. That compares to ~200 $m^2$ in the portion of Hobsonville shown.


Source: PCE[73]

**Figure 2.18: The changing face of residential development and associated changes in green space: Westmere, built 1930s; Mount Roskill, built 1950s; Long Bay, standalone housing, built 2010s; Hobsonville, terraced housing, built 2010s.**

[73] Aerial imagery sourced from the LINZ Data Service and licensed by Auckland Council and AAM NZ Limited for reuse under CC BY 4.0.

# 3

*Notogrammitis gunnii*

# Providing and protecting green space in New Zealand cities

This chapter discusses the role that central and local government play in providing and protecting urban green space in New Zealand.

There has always been a market for private green space. The absence of its provision owes as much to planning rules (including densification requirements) as it does to developers seeking to maximise development opportunities. That said, the market for private green space will not always guarantee services such as temperature regulation, stormwater management and habitat provision, the values of which are difficult for landowners or developers to capture.

But when it comes to the provision of public green space, we are in the world of public goods from which a non-paying public cannot be excluded. The market by definition will not provide large public open spaces. While some sporting facilities (golf clubs, for example) can exclude the wider public on the basis of membership requirements, the reality is that open space provision in New Zealand cities relies heavily on the involvement of local and central government.

The chapter begins by briefly describing the policy framework that governs urban development generally – from high-level spatial planning all the way through to residential construction. This framework is important because the built form that emerges exerts a strong influence on the distribution of green space in our cities.

The chapter then looks specifically at how government goes about providing and protecting urban green space – both in the public realm and on privately owned land. The legislative framework for council decisions on green space involves three main statutes: the Resource Management Act 1991, the Local Government Act 2002, and the Reserves Act 1977 (Figure 3.1). Others, including the Urban Development Act 2020 and Infrastructure Funding and Financing Act 2020, are also important.

| | Public urban green space | Private urban green space |
|---|---|---|
| Provision | • Development contributions **(LGA)**<br>• Financial contributions **(RMA)**<br>• Esplanade and road reserves **(RMA)**<br>• Funding via long-term plans **(LGA)**<br>• Funding via future residents **(IFFA)** | • District plan provisions **(RMA, MDRS NPS-UD, draft NPS-IB)**<br>• Soil provisions **(Building code and NZS 3604:2011)** |
| Protection | • Bespoke legislative protections **(various)**<br>• Reserve status **(Reserves Act)**<br>• Other protections **(LGA)** | • Vegetation protections **(RMA, draft NPS-IB, SNAs and SEAs)**<br>• Wetland and soil protections **(NPS-FW and NPS-HPL)**<br>• Tree protections **(RMA)** |

Notes:

- IFFA = Infrastructure Funding and Financing Act 2020
- LGA = Local Government Act 2002
- MDRS = Medium Density Residential Standards
- NPS-FW = National Policy Statement for Freshwater Management
- NPS-HPL = National Policy Statement for Highly Productive Land
- draft NPS-IB = draft National Policy Statement for Indigenous Biodiversity
- NPS-UD = National Policy Statement on Urban Development
- SNAs = Significant Natural Areas
- SEAs = Significant Ecological Areas
- RA = Reserves Act 1977
- RMA = Resource Management Act 1991

Source: PCE

**Figure 3.1: Summary of legislation influencing the provision and protection of urban green space.**

A number of headline messages emerge from the chapter.

- There is no requirement to plan for or provide public green space in New Zealand cities. Unlike other forms of infrastructure – notably roads and three waters networks – parks provision is at the discretion of councils. According to parks planners and managers spoken to during this investigation, this lack of guidance tends to mean that parks and reserves are treated as a discretionary 'nice to have' when hard decisions about provision levels and funding are made.

- Most Tier 1 councils do publish level of service statements for public green space. These statements are critical because they inform decisions about parks provision in structure plans, and the level of development contribution (and other sources of funding) that will be required to pay for it. At present, most councils only publish formal provision targets for the neighbourhood and suburb parks that are common in residential areas. In area terms, these targets often amount to only 1–2% of the development area – a fraction of what has been provided historically.
- Retrofitting new public green space into existing urban areas is much more difficult than incorporating it in new greenfield subdivisions. Some councils – Auckland Council, Hamilton City Council and Tauranga City Council included – have formally stated that they are no longer seeking to provide new parks and reserves in already built-up areas, and will instead focus on improving the quality of the existing network. In the short term, that may be a pragmatic approach to elevated land prices – there is certainly no shortage of opportunities to revegetate existing areas of public land. In the long term, it may become problematic if intensification results in many more people living in areas where parks and reserves are in short supply.
- Councils do not appear to be using the full extent of the powers that are available to create new public green space. In brownfield areas, reserve contributions fall well short of the 7.5% maximum allowed under the Local Government Act 2002. They are arguably also poorly designed, with the contribution being levied often bearing little relationship to the quantity of 'on-site' green space that is preserved. In greenfield development areas, the current practice of not completely specifying the amount – and location – of desired parks provision until the resource consent phase creates uncertainty. Much of that could be avoided if councils were more explicit about their expectations regarding parks provision prior to up-zoning rural land.
- When it comes to the distribution of private green space (e.g. yards and gardens), planning rules are particularly important. Traditionally, 'standalone' single house zones have dominated residential land use planning in New Zealand cities. These typically limited the area of a section that could be built upon to between 35 and 55%. Some plans also include rules relating to maximum impervious coverage – typically between 60 and 70% of the site area. The ability of the remaining site area to host vegetation is far from assured, however – the removal of topsoil during the development process and the increasing use of artificial turf and permeable pavers both pose barriers.
- Recent central government direction via the National Policy Statement on Urban Development (NPS-UD) and Medium Density Residential Standards (MDRS) focuses on promoting urban development inwards and upwards. If reducing transport emissions and congestion is the goal, both strategies are almost certainly preferable to development outwards. That said, both policies also pose considerable risks for urban green space. The MDRS in particular, with its focus on promoting medium-density infill development across broad swathes of our cities, has the potential to accelerate the ongoing reduction in private green space documented in chapter two with little consideration apparently being given to how improved public green space could help to compensate for that.

- Protections provided by the Reserves Act represent a significant barrier to the disposal of urban parks and reserves. Since January 2017, 57 parcels of land (22 hectares) in Tier 1 cities have had their reserve status revoked.[1] It is notable that the difficulty of revoking the reserve status of land has seen proponents of development resort to the use of local bills to remove existing protections.
- By contrast, the effectiveness of the system for protecting vegetation on private land is questionable. The implementation of Significant Natural Areas (SNAs) in urban areas has been mixed at best (although the draft National Policy Statement for Indigenous Biodiversity will go a long way towards addressing that, if implemented). Similarly, changes made to tree protection rules in the Resource Management Act (RMA) in 2009 and 2013 make it very difficult for councils to schedule and protect trees that provide significant environmental or amenity value (although changes proposed as part of the Natural and Built Environment Bill may help). While regulatory 'sticks' certainly have an important role to play in protecting vegetation on private land, there is a question as to whether greater use could be made of financial 'carrots'. Rebates to financial contributions or property rates in exchange for the creation of legal covenants over valuable trees or vegetation is an approach that could be considered further.

## The policy framework governing urban growth in New Zealand

Urban development, whether in peri-urban or already built-up areas, has significant implications for the availability of urban green space.

On the one hand, development can increase the pressure on a city's green spaces, whether through the loss of private yards and gardens as infill housing and intensification occurs,[2] or through increased recreational demand for pre-existing public spaces as the number of residents grows. On the other hand, development can create opportunities to provide new green spaces. In greenfield areas, the transformation of rural land into new suburbs creates an opportunity to set some green, open space aside for public use. In already existing urban areas, comprehensive block- or suburb-scale redevelopment (of the sort undertaken by Eke Panuku Development Auckland or Kāinga Ora) can allow some previously built upon land to be revitalised as parks or reserves.

There are five main stages involved in the urban growth process in New Zealand:

- spatial and structure planning
- zoning
- infrastructure provision
- resource (subdivision) consent
- construction.

This section introduces the policy framework governing each of these, and briefly discusses the key implications for urban green space.

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[1] As discussed in chapter two, however, a significantly larger area of new public green space was created in Tier 1 cities during the same period.

[2] Stanley et al., 2015.

## Spatial and structure planning



The zoning policies and rules contained in district plans are often informed by an earlier phase of non-statutory planning. This is typically carried out at two distinct scales: regional/district (via spatial plans) and suburb (via structure plans).

With the exception of Auckland Council,[3] local government in New Zealand has not been required to undertake spatial planning. This will change if the proposed Spatial Planning Bill introduced in November 2022 is passed into law.

Nevertheless, many councils – and particularly those with significant urban populations – have chosen to produce spatial plans or strategies as a way to align expectations about how a city will grow and change over the medium term. Hamilton City Council has the *Hamilton Urban Growth Strategy*,[4] Tauranga City Council and Western Bay of Plenty District Council have the *SmartGrowth Joint Spatial Plan*, and Wellington City Council has *Our City Tomorrow: A Spatial Plan for Wellington City*.

In the context of this report, a critical element of these documents is the vision they portray of how future growth will be distributed between already built-up areas and the peri-urban fringe. This has implications for urban green space because providing new parks and vegetated road berms in existing urban areas comes with very different challenges from those in a peri-urban 'blank canvas'.

The desired balance between intra- and peri-urban development varies widely across cities. In Tauranga, the 2021 *SmartGrowth Joint Spatial Plan* envisaged 65–70% of future population growth being accommodated in new peri-urban subdivisions.[5] In Auckland, the balance is weighted firmly towards already existing urban areas, which are expected to absorb 60% of the 313,000 dwellings thought to be required by 2048.[6] The same is true in Hamilton, where the *Draft Hamilton Urban Growth Strategy* seeks to accommodate 70% of long-term growth through intensification.[7] Wellington City has a particularly strong focus on intensification: no more than 5–10% of the 24,000 to 30,000 dwellings expected to be built by 2047 will be in new peri-urban subdivisions.[8]

The Government's recently promulgated intensification requirements will likely increase the share of intra-urban growth within Tier 1 cities. So will those provisions of the National Policy Statement for Freshwater Management (in particular, around wetlands) and the National Policy Statement for Highly Productive Land that constrain some outward growth.

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[3] The Local Government (Auckland Council) Act 2009 s 7(4)(d) requires Auckland Council to prepare and adopt a spatial plan. Among other things, this plan must "identify the existing and future location and mix of—

(i) residential, business, rural production, and industrial activities within specific geographic areas within Auckland; and

(ii) critical infrastructure, services, and investment within Auckland (including, for example, services relating to cultural and social infrastructure, transport, open space, water supply, wastewater, and stormwater, and services managed by network utility operators)".

[4] The *Hamilton Urban Growth Strategy* emerged from Future Proof – a sub-regional spatial planning exercise undertaken by the Waikato Regional Council together with four territorial local authorities, Waka Kotahi and mana whenua (Future Proof, 2022b). An updated draft version of the strategy has recently been published (Hamilton City Council, 2022b).

[5] SmartGrowth, 2021b, p.55.

[6] Auckland Council, 2018, p.217.

[7] Hamilton City Council, 2022b, p.20.

[8] Wellington City Council, 2021b, p.9.

Owing to the scale at which they are developed, spatial plans do not tend to contain much detail about the fabric of future peri-urban developments. This detail is left to structure plans. These are typically developed for each of the peri-urban growth cells (or 'nodes') that councils have identified. Structure plans set out a vision for how these areas will be developed, including the indicative location of zoning boundaries, major infrastructure corridors, and parks and reserves.

In many cases, the infrastructure corridors and sites identified in spatial and structure plans are then formally demarcated through the use of designations. These are provided for under the RMA (and the Natural and Built Environment Bill) and give infrastructure providers – both public and private – a legal means of ensuring that current land use does not compromise infrastructure provision in the future.

Under the RMA (and the Natural and Built Environment Bill), territorial authorities can use designations for a broad range of eligible infrastructure, as well as any public work for which it has financial responsibility.[9] Notably, those definitions extend to the network of public parks and reserves that councils administer. Some councils make extensive use of designations to demarcate the location of future parks and reserves. As of January 2023, the Auckland Unitary Plan contained 23 designations for regional parks and 27 designations for local parks and public open space.[10] Other councils make less use of designations for this purpose. The Tauranga City Plan, for example, contains just one designation for a sports park, one designation for a local purpose reserve, and one designation for an esplanade reserve.[11]

## Zoning

Under the existing resource management system, the results of spatial and structure planning exercises have no legal effect until they are translated into the statutory planning documents required by the RMA: regional policy statements, regional plans and district plans. Ultimately, it is changes to the policies and rules contained in these documents that enable any new development, whether in peri-urban or already existing urban areas.

District plans divide a district into discrete areas or zones with different objectives, policies and rules. The geographic extent of individual zones and the stringency of the rules applied to them exert a strong influence on the built form of a city and the distribution of green space within it. Cities that promote low-rise standalone residential development will – all else being equal – tend to consume more peri-urban rural green space (and preserve more intra-urban green space) than those that promote a denser built form. That is not to say that cities cannot be both dense and green at the same time. They can, but for that to happen, local government has to prioritise and – just as importantly – fund new areas of public green space as development upwards and inwards proceeds.

The resource management reforms currently being progressed by the Government will change the way that urban planning is undertaken with a much stronger emphasis on regional-scale decision making and resolving conflicts at the planning stage. What will not change is the influence that the resulting planning policies and rules will have on the fabric of our cities – and the green space within them.

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[9] RMA, s 168; Natural and Built Environment Bill, s 503.

[10] Auckland Council, 2022b, chapter K.

[11] Tauranga City Council, 2022e, chapter 10C.

In both the existing and future resource management systems, up-zoning is generally the 'trigger' required for new subdivision and development. Because it allows for higher-value land uses, up-zoning tends to generate windfall capital gains for landowners. Data from Auckland, for example, indicate that rural land that was up-zoned for development between 2014 and 2017 increased in value by 200–500%.[12]

Those windfall gains should give councils considerable leverage when it comes to negotiations about the amount of green space that is to be set aside from development. A council seeking to provide material areas of green space could reasonably argue that since the significant uplift in value accruing to landowners is a result of regulatory change rather than any value the landowner has added, the extent of that value uplift should be tempered by the need to retain some of the land for public goods such as green space. Alternatively, any compensation for a requirement to hold land aside from development as public green space should be limited to the value of the land prior to any value uplift caused by zoning change.

In practice, negotiations about which parcels of land are to be set aside as public green space are often left to the subdivision consent stage (see below), by which time new residential zoning is in place and land prices have already appreciated significantly. This makes it more difficult for councils to set aside green space of any size. In effect, councils are conferring private gains, which then make it much more costly for them to secure public goods.

## Infrastructure provision

Even if land is zoned appropriately, residential development is unlikely to proceed unless certain types of infrastructure – trunk roads and three waters networks, for example – are in place. Few developers would be willing to begin construction without some assurance that the resulting houses will be connected to existing networks upon completion.[13]

Responsibility for providing trunk transport and three waters infrastructure generally falls to councils, albeit with varying degrees of assistance from central government.[14] This is no small job. Large-scale infrastructure projects are expensive, involve long lead times, and are administratively and technically complex. For councils, there are considerable financial risks involved. Investment in roads and three waters networks are predicated on forecasts of future growth that are ultimately uncertain. To the extent that growth fails to materialise, councils are left with higher interest and depreciation costs, and a smaller-than-expected rating base to service them.

[12] Auckland Council, 2022j – GeoMaps, property – revaluation layer.

[13] Local Government New Zealand notes that "in essence, the availability/future provision of infrastructure is a de-facto urban limit … ultimately, the land is not 'shovel ready' until main trunk infrastructure has been extended to a point at which it becomes economical for a developer to meet the cost of connecting" (New Zealand Productivity Commission, 2015, p.166).

[14] In the case of transport, for example, 53% of councils' funding requirements comes from the National Land Transport Fund (Waka Kotahi NZ Transport Agency, 2021).

The difficulties that councils have experienced in providing the infrastructure needed to enable urban growth have been widely canvassed. Financing challenges have received particular attention. A number of high-growth councils have run up against debt limits in recent years, making responding to above-average levels of population growth difficult.[15] The political economy of enabling growth has also been challenging. Rates increases required to service additional debt are never popular. Development contributions help to shift the cost burden towards the ultimate beneficiaries of urban development – future residents – but also tend to be strongly contested by developers.

In recent years, central government has employed several tactics to try to improve the responsiveness of infrastructure supply. These include:

- **Regulation**

  As part of the NPS-UD, the Government requires Tier 1 councils to "provide at least sufficient development capacity to meet expected demand for housing and for business land". In the short to medium term, that means that development infrastructure either already exists or is identified in a long-term plan.

- **New funding tools for local government**

  The Infrastructure Funding and Financing Act 2020 eases the constraint posed by debt ceilings by allowing councils to borrow for infrastructure through so-called special purpose vehicles. The debt that results is backed by levies paid annually by the households that benefit from the new or improved infrastructure.

- **Central government funding assistance**

  The $3.8 billion Housing Acceleration Fund (2021) includes significant funding for infrastructure that enables housing development.

Not all infrastructure needs to be in place – or near completion – for urban development to proceed.[16] In the context of this report, for example, there is no obvious reason why developers would be hesitant to break ground on a new greenfield suburb if parks and reserves were yet to be created.

Nevertheless, parks and reserves require deliberate provision in exactly the same way that built infrastructure does. Which raises the question: Are the requirements imposed on councils (and funding tools available to them) the same for parks and reserves as for built infrastructure? Box 3.1 explores this further.

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[15] Recent population growth in New Zealand's major cities has been particularly rapid. Auckland's population increased by an average of ~2% between 2016 and 2020, compared with 1.5% between 2011 and 2015, and 1.3% between 2006 and 2010. Tauranga's population increased by almost 4% year on year between 2016 and 2020, but only around 2% in the 5-year periods preceding that (Stats NZ, 2022c).

[16] The New Zealand Productivity Commission (2017) differentiates between 'structural' infrastructure – main roads, three waters, schools and hospitals – and 'follower' infrastructure – streets, lighting, parks and community facilities. The former is described as providing the 'skeletal' framework for urban development whereas the latter provides services once the suburb or neighbourhood in question has emerged.

**Box 3.1: Is urban green space a type of infrastructure?**

Most definitions of infrastructure include some reference to its built or human-made character. The 2011 National Infrastructure Plan, for example, defines infrastructure as "the fixed, long-lived structures that facilitate the production of goods and services and underpin many aspects of quality of life".[17]

Definitions like this exclude natural assets such as urban forests, wetlands, riparian strips or other types of green space. On the one hand, that is sensible. Natural assets are fundamentally different to built assets: their creation requires decades to hundreds, if not thousands of years, and once established they do not depreciate in the way that built assets do. On the other hand, natural assets provide many of the same services that built assets do. The United States Congress, for example, recently acknowledged the role that nature plays in filtering and absorbing stormwater.[18]

While debating naming conventions may seem peripheral, what is – and is not – classed as infrastructure has practical implications for funding sources and the suite of regulatory tools that are available to councils.

- The NPS-UD distinguishes between "development infrastructure" – the three waters and roading infrastructure required to serve new developments – and "additional infrastructure" – things like open space and community facilities. Councils must be "satisfied" that the latter "is likely to be available" but are *required* to provide the former.
- The Local Government Act 2002 (section 101b) *requires* councils to prepare infrastructure strategies that cover the following groups of assets: water supply; sewerage and the treatment and disposal of sewage; stormwater drainage; flood protection and control works; and the provision of roads and footpaths. Councils can, *at their discretion*, choose to include other types of assets – public parks and reserves, for example.
- The Local Government Act 2002 (part 8, subpart 5) allows councils to levy development contributions to help fund the infrastructure associated with urban growth. The formulas used for traditional built infrastructure and parks and reserves are different. Development contributions for parks and reserves are capped at 7.5% of the value of allotments created by the subdivision.[19] *No such cap exists* for traditional built infrastructure.
- The recently created Infrastructure Acceleration Fund contains $1 billion in central government funding for *enabling* infrastructure: transport, three waters and flood protection.[20] Similarly, the National Land Transport Fund provides $1–1.5 billion in central government funding for local transport infrastructure.[21] No such funding is available for local parks and reserves unless they are part of stormwater infrastructure.

[17] Te Tai Ōhanga – The Treasury, 2011, p.1.

[18] The Water Infrastructure Improvement Act defines green infrastructure as "the range of measures that use plant or soil systems, permeable pavement or other permeable surfaces or substrates, stormwater harvest and reuse, or landscaping to store, infiltrate, or evapotranspirate stormwater and reduce flows to sewer systems or to surface waters" (US Congress, 2019, p.5560).

[19] Local Government Act, 2002, s 203.

[20] Kāinga Ora, 2022.

[21] Waka Kotahi NZ Transport Agency, 2022.

## Resource (subdivision) consent

Under the RMA, land cannot be subdivided unless the subdivision is "expressly allowed by … a rule in a district plan".[22] The Natural and Built Environment Bill contains similar provisions. Unless enabled by another Act, subdivision must either be enabled by a framework rule, or a plan rule within the jurisdiction of a territorial authority.[23]

Very few district plans provide for subdivision as a permitted activity.[24] That generally means that developers or landowners need to apply for resource consents before development begins.

In granting resource consents, territorial authorities have wide-ranging powers to impose conditions – some of which can affect the distribution and quality of green space within a development. The RMA sets out a number of conditions that are explicitly allowed for, many of which have been translated into the Natural and Built Environment Bill (as of January 2023). These include the ability to:

- levy financial contributions (environmental contributions under the Natural and Built Environment Bill), which can be a contribution of money, land, or combination of both (see the 'Development versus financial/environmental contributions' section below)
- require that "services or works, including (but without limitation) the protection, planting or replanting of any tree or other vegetation or the protection, restoration, or enhancement of any natural or physical resource, be provided"[25]
- require esplanade reserves and strips to be set aside (see the 'Esplanade strips and reserves' section below).

Councils can impose a broader range of conditions on resource consent applications than those explicitly identified in the RMA. One important example in the context of this report relates to the requirements that councils specify for infrastructure that will be transferred to them on completion of subdivision. When it comes to roads and three waters networks, councils typically establish a set of quite specific minimum standards, either in subdivision or engineering codes of practice (referenced in the district plan) or in the district plan itself.[26,27] Parks and reserves tend to be treated differently. Council expectations are set out in a range of places (see the 'Levels of service' section below), tend to be less tightly specified, and lack an explicit link to district plan policies and rules.

Conditions on subdivision consents can also be imposed under other legislation. The Local Government Act 2002, for example, allows territorial authorities to levy development contributions to help fund growth-related infrastructure, including parks and reserves. Development contributions and their relationship to financial contributions are discussed further below.

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[22] RMA, s 11.

[23] Natural and Built Environment Bill, s 18.

[24] Quality Planning, no date a.

[25] RMA, s 108(2)(c).

[26] Quality Planning, no date b.

[27] These standards often extend to the extent and type of vegetation to be included in the road corridor or stormwater network.

## Construction

The final phase of urban development involves the construction of new dwellings, commercial premises, public buildings etc. Under the Building Act 2004, developers are required to apply for building consent to demonstrate that what is being built complies with the provisions of the New Zealand Building Code.[28]



The Building Code establishes minimum performance levels across a range of dimensions, including stability, protection from fire, access, moisture and energy efficiency. Developers can choose to meet these performance levels in any way they see fit. Alternatively, they can choose to demonstrate compliance through the use of "acceptable solutions", which specify a set of preapproved construction methods and practices. These are developed by the Ministry of Business, Innovation and Employment – Hīkina Whakatutuki, and are reviewed annually.[29]

For developers, an important advantage of adopting acceptable solutions is regulatory certainty – under the Building Act, consent authorities must grant consent for designs based on them.[30] In practice, that means that the content of acceptable solutions exerts a strong influence over much of what is built in New Zealand and accounts for the visual similarity (some would say monotony) of much of urban New Zealand. Depending on your view of the content of an acceptable solution, that can be a good or a bad thing.

When it comes to the treatment of soil in residential development areas, New Zealand Standard (NZS) 3604:2011 is particularly important. It includes a set of acceptable solutions for the small (less than ten metres high) timber-framed buildings that are common in new urban subdivisions. Significantly, NZS 3604:2011 only applies to buildings constructed on "good ground", the definition of which explicitly excludes "potentially compressible ground such as top soil".[31] For the vast majority of sites where topsoil exists, that leaves developers with two options: scrape off the topsoil and proceed as an acceptable solution or apply for a "specific engineering design".

This may explain why topsoil is often removed prior to residential construction. While this may appear innocuous, it has long-lasting consequences for the permeability of ground in residential areas, how much water it can store, and what will grow in it far into the future.

[28] The Building Code is secondary legislation created under the Building Act.

[29] MBIE, 2022.

[30] Building Act, s 22.

[31] Standards New Zealand, 2011, p.16.

## How public urban green space is created

### Levels of service

There is no statutory requirement for territorial authorities to plan for or provide public green space in New Zealand. As noted above in Box 3.1, that makes parks and reserves different from the other types of infrastructure that local government provides in cities.

Green space provision has not always been discretionary. Historically, various pieces of central government legislation have required new urban areas to include a certain amount of green space. An early example of this was the Plan of Towns Regulation Act 1875. This required a minimum of 10% of the area of new towns on Crown land to be recreational reserves.[32] Such requirements continued to exist until the 1960s,[33] and probably go some way to explaining why New Zealand cities have the public green space endowments they do.

Today, local authorities have more freedom to determine what amount of public green space is appropriate. Council aspirations in this respect are typically set out in level of service statements, which are generally found in long-term plans, open space provision strategies or development contribution policies.

These documents typically divide council-owned green space into a number of categories based on their intended function. Thus, according to Auckland Council's *Open Space Provision Policy 2016*, pocket parks provide "'doorstep access' to small amenity and socialising spaces in high density residential areas", while destination parks provide "for large numbers of visitors, who often visit for an extended period of time, and may travel from across Auckland."[34]

Quantity-based provision targets are then attached to some (but not all) of these categories using one of two metrics: hectares of open space per person, or the proportion of residents living within walking distance of a park (Table 3.1).[35] These targets are important because they represent the starting point for green space provision in new greenfield developments and, ultimately, the size of the development contributions that are required to pay for it.

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[32] Plans of Towns Regulation Act 1875, s 3. The Act required a further 10% be set aside for various public purposes.

[33] For example, s 28 of the Counties Amendment Act 1961 required new residential subdivisions to include a minimum of 100 $m^2$ of open space for each new allotment that was created.

[34] Auckland Council, 2016, pp.30–31.

[35] Level of service statements commonly also include objectives relating to open space quality – location, connectivity, size, topography, presence of associated infrastructure, ecological function etc.

**Table 3.1: Summary of open space level of service targets in selected Tier 1 cities.[36]**

| Open space type | Linear parks and green-ways | Local/ pocket park (0.1–0.3 ha) | Neigh-bour-hood park (0.3–0.5 ha) | Suburb/ comm-unity park (2–5 ha) | City-wide park (> 10 ha) | Destin-ation park (> 30 ha) | Conser-vation and natural areas | Sports fields | All open space |
|---|---|---|---|---|---|---|---|---|---|
| **Auckland** | – | – | 1 within 400–600 m | 1 within 1,000–1,500 m | – | – | – | – | – |
| **Tauranga** | – | 1.7 ha/1,000 people; and 1 local park within 2,000 m; and 1 neighbourhood park within 400 m | | 1 within 4,000 m | 1 within 5,000 m | – | – | Meet demand | – |
| **Hamilton** | – | – | 1 within 500 m | 1 within 1,500 m | – | – | – | Deter-mined by demand | – |
| **Upper Hutt** | – | – | – | – | – | – | – | – | 1 within 300 m |
| **Lower Hutt** | – | – | – | – | – | – | – | – | 1 within 400 m |
| **Porirua** | – | – | 1 within 600 m | – | – | – | – | – | – |
| **Wellington** | – | – | 1 within 600 m | – | – | – | – | – | – |
| **Christchurch** | – | – | – | – | – | – | – | – | 1 within 500 m |

As shown in Table 3.1, most large councils prefer to define open space levels of service in terms of accessibility – i.e. how far most residents have to travel to visit a park or reserve. There is nothing wrong with that, but it does suggest that councils are more focused on the recreational benefits of green space than the various environmental services it can provide. A focus on services like temperature regulation, stormwater management and habitat provision would imply greater attention be given to the area (and quality and interconnectedness) of the green space being provided.

At the same time, few councils appear to be setting formal provision targets for anything other than traditional neighbourhood or suburb/community parks. In some cases, this is probably sensible. A blanket provision target for conservation or natural areas would make little sense in new greenfield areas where few or no natural remnants have survived. That said, the general absence of targets for green spaces larger than five hectares (Tauranga excepted) raises the question of whether financing these has been placed out of reach.

[36] Auckland Council, 2016; Hamilton City Council, 2018; Tauranga City Council, 2012; Tauranga City Council, 2022c; Upper Hutt City Council, 2018; Hutt City Council, 2016; Porirua City Council, 2021a; Wellington City Council, 2013; Christchurch City Council, 2022b.

The accessibility targets shown in Table 3.1 are readily translated into area and area per-capita terms. For example, a 4,000 square metre neighbourhood park amounts to around 0.5% of the area of a circular neighbourhood with a 500-metre radius. At population densities of 2,000–4,000 people per square kilometre, the same park provides 1–3 square metres of public green space per resident. These provision targets are a fraction of existing public green space endowments (see chapter two), suggesting that a continuation of current policy settings will steadily erode the city-wide availability of public green space.[37]

One thing that is not necessarily apparent from Table 3.1 is that provision targets for public green space do not tend to vary according to the density of the surrounding suburb. That seems surprising. More densely populated areas dominated by townhouses, terraced houses or apartments (with little backyard space) arguably have a greater need for nearby parks and reserves than suburbs dominated by standalone housing. Some councils have recognised that. Wellington City Council, for example, is developing an open space and recreation strategy that targets a five-minute walk to an open space in high-density areas, and a ten-minute walk in other areas.[38]

Furthermore, many of the provision targets are specific to greenfield areas. In recent years, a number of councils have acknowledged that they are no longer seeking to provide additional green space within the existing urban footprint and will instead focus on improving the quality of the network that already exists. For example, Auckland Council's *Open Space Provision Policy* states:[39]

> "The existing urban area of Auckland has an established, well distributed, open space network. The ability to significantly expand the urban network is constrained due to the land supply and budget constraints. Therefore, council's investment in open space in the existing urban area prioritises improving the existing network."

Hamilton City Council's *Draft Open Space Provision Policy* sets out a similar approach. Rather than attempting to acquire land for new parks and reserves in the existing urban area, it aims to "optimise existing open space through reconfiguration, upgrades and development" and "improve accessibility and connectivity to existing open space through alterations to the surrounding pedestrian network".

In Tauranga, the focus in existing urban areas is on "making the most of what we have".[40] According to Tauranga City Council's *Open Space Level of Service Policy*, that means a focus on the "accessibility, quality and function of open spaces" rather than "more people = more open space".

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[37] Care is required with interpretation here, however. 'Neighbourhood', 'suburb', and 'sports' parks are not the only types of green space provided by territorial authorities – esplanade reserves and ecological/nature corridors can also be important. And territorial authorities are not the only providers of public green space in New Zealand cities. Some of the divergence between existing endowments and council targets will reflect these factors.

[38] Wellington City Council, pers. comm., 5 December 2022.

[39] Auckland Council, 2016, p.8.

[40] Tauranga City Council, 2022c, p.8.

## New public green space as part of the subdivision process

Most new public green space in New Zealand cities is created as part of greenfield subdivision and development.



Councils have two main points of leverage when it comes to securing public green space from the development process. The first is at the plan change stage, where natural areas, riparian strips and land required for public infrastructure can be excluded from up-zoning. The second is via subdivision consent, where the dimensions and characteristics of local parks, street berms and green stormwater infrastructure can be specified.

Councils have a range of tools available to help them acquire the land for new public green space. Under the Local Government Act 2002, they can charge what are termed 'development contributions' – either in cash or in kind – to help provide the parks and reserves needed to service growth. Under the RMA (and the Natural and Built Environment Bill), they can charge 'financial (or environmental) contributions' – either in cash or in kind – to mitigate the adverse environmental impacts of development. The RMA (and the Natural and Built Environment Bill) also allow councils to extract coastal and riparian strips of up to 20 metres in width when subdivision results in sections of less than four hectares in size.

The following sections focus on these (and related) tools. But it is important to note that not all of the green space set aside by greenfield development is necessarily vested in councils. In some cases, significant areas of private land can be retained as green space through the use of zoning, overlays or covenants (Box 3.2). Although such areas will not generally offer the recreational use benefits that parks and reserves do, they can still provide a full range of environmental services.

**Box 3.2: The retention of private green space in the Plimmerton Farm development**

Plimmerton Farm is a 386-hectare greenfield development area situated on the northern margin of Porirua City. A plan change approved in February 2021 will eventually allow upwards of 2,000 new houses to be built on the site.[41] Significantly, the plan change includes provisions that will effectively mean around one third of the site will be retained as large areas of semi-contiguous green space. Porirua City Council used two specific mechanisms to enable that.

The first relates to significant natural areas, which, under the RMA, councils are required to recognise and provide for.[42] Porirua City Council was in the process of mapping these across the district as the Plimmerton Farm plan change was being developed. That mapping process identified several gullies in the development area that contained remnant vegetation worthy of protection.

The second mechanism relates to so-called biodiversity offsetting and restoration areas (BORAs) – a term developed by Porirua City Council. These were negotiated during the Plimmerton Farm plan change process, partly in response to concerns about the potential effects of development on a significant wetland (Taupō Swamp) located on the western (downstream) margin of the development area.[43] Subdivision and development of sites containing a BORA is possible,[44] but any buildings and access roads will generally need to be located beyond the protected area.[45] In addition, subdivision will generally need to be accompanied by an ecosystems and indigenous biodiversity management plan that, among other things, specifies how the site is to be restored.

## Creating new parks and reserves using the development contribution process

### Basic development contribution framework

Under the Local Government Act 2002, territorial authorities can levy development contributions to enable them "to recover from those persons undertaking development a fair, equitable, and proportionate portion of the total cost of capital expenditure necessary to service growth over the long term."[46]

The types of assets for which development contributions can be levied are tightly restricted to reserves, network infrastructure and community infrastructure. The Local Government Act 2002 does not define what is meant by 'reserves' but does make clear that they include "community or recreational facilities associated with the use of a reserve".[47]

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[41] Green, 2021.

[42] RMA, s 6.

[43] BORAs are located around the upper catchments of the streams that dissect the development area, thereby expanding the area covered by SNAs.

[44] Porirua City Council, 2021b – Plimmerton Farm Zone, SUBPFZ-R3.

[45] Porirua City Council, 2021b – Plimmerton Farm Zone, SUBPFZ-P5.

[46] Local Government Act 2002, s 197AA.

[47] Local Government Act 2002, s 205(a).

Development contributions can comprise money, land or a combination of both.[48] The ability to levy cash contributions is particularly important given the fragmented, staged and sometimes small-scale nature of new developments. When it comes to the provision of reserves, this allows councils to pool contributions from a series of projects and use the resulting funds to acquire meaningfully sized and/or ecologically coherent tracts of land.

In practice, the decision as to whether levy reserve contributions are in cash or in kind appears to depend considerably on the scale of the development being proposed. Cash is the dominant mode of payment for two- or three-lot subdivisions in already built-up areas because there is generally insufficient land available for the creation of a meaningful playground or park. For larger subdivisions in greenfield areas, in-kind contributions are more common. Some councils (Tauranga City Council, for example) negotiate these into development agreements.

**Calculating the rate of development contributions**

Section 203 of the Local Government Act 2002 limits the maximum development contribution that local authorities can levy. Importantly, the method for calculating this maximum contribution differs according to whether traditional built infrastructure (roads, wastewater networks, libraries etc) or green infrastructure (parks and reserves) is being considered.

The maximum development contribution for traditional infrastructure is determined using a formula.[49] Essentially, local authorities are required to specify the total cost of the capital expenditure they expect to incur to meet increased demand resulting from growth, and spread this across the number of new dwellings associated with development.

The method for establishing the maximum contribution payable in respect of reserves is more restrictive. Local authorities are still required to identify the cost of reserves and facilities required to accommodate growth, but the development contributions levied to meet this cost cannot exceed the greater of (i) 7.5% of the value of the additional allotments created by a subdivision, and (ii) the value equivalent of 20 square metres of land for each additional household unit or accommodation unit created by the development.[50]

It is worth noting that limitations on maximum reserve contributions are relatively new and follow a progressive diminution in minimum contributions required by statute over the last 150 years (Box 3.3).

[48] Local Government Act 2002, s 197(2).

[49] Local Government Act 2002, schedule 13.

[50] Local Government Act 2002, s 203.

**Box 3.3: Changes in contributions policy through time**

Central government direction on the provision of urban parks and reserves has waxed and waned since the very early development of New Zealand towns and cities.

The first piece of legislation to formalise requirements for urban green space was the Plan of Towns Regulation Act 1875. This required new towns on Crown land (e.g. Rotorua) to have a minimum of 10% of their area set aside for recreation reserves. From 1897 a minimum of 10% of the area of every town was required to be held in recreation reserves.[51]

A post-war housing supply crisis from 1918 to 1922 saw the requirement for park provision on private land reduced to 5% of the land being subdivided.[52] With the passing of the Town Planning Act 1926, that requirement was removed altogether, with each local body given discretion to determine the appropriate amount of park and reserve land.[53]

In the late 1940s, concerns about rapid urban sprawl led to the reintroduction of central government direction on public green space provision. Peri-urban subdivisions now needed to provide a minimum area of land or of money toward reserves: at least 101 square metres for every residential allotment, plus at least 10% of the area of every business or industrial allotment over 1,011 square metres.[54]

The Local Government Amendment Act 1978 saw powers returned to local government, with councils able to set their own reserve policy or rules in the relevant district scheme. Where no such policy existed, the Act instructed councils to "have regard to the desirability of providing reserves in the locality totalling not less than 4 hectares for every 1,000 of the likely maximum resident population of the locality".[55] That amounts to 40 square metres per resident.

The Local Government Amendment Act 1978 also marked a switch from minimum to maximum park provision requirements.[56] For new subdivisions, "reserve contributions" were now to be a maximum of 130 square metres per residential allotment or 7.5% of the value of these allotments, plus 10% of the value of each new business or industrial allotment. For development within an already established part of a city, contributions were to be a maximum of 20 square metres for each additional residential unit and 0.5% of the value of business and industrial development.

New resource management legislation in the early 1990s did away with reference to subdivision consents requiring land for reserves.[57] Instead, resource consent conditions could include financial contributions. The Local Government Act 2002 then introduced "development contributions" to cover the capital costs of urban growth. The amounts specified drew upon the 1970s legislation: a maximum of 7.5% of the value of allotments in new subdivisions and 20 square metres per new accommodation unit in new developments.[58]

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[51] Survey Regulations 1897, ss 32, 34.

[52] Survey Regulations 1923, ss 110, 114; Survey Regulations 1925, ss 161, 164.

[53] Dodge, 2017.

[54] Land Subdivisions in Counties Act 1946, ss 12, 14; Municipal Corporations Act 1959, s 28; Counties Amendment Act 1961, ss 28, 45.

[55] Local Government Amendment Act 1978, s 284.

[56] Local Government Amendment Act 1978, ss 285, 286, 294.

[57] On enactment, s 220 of the RMA explicitly allowed councils to include conditions requiring a contribution of land or other financial contribution for reserve purposes in subdivision consents (NZLII, no date). Amendments to the RMA in 1993 removed that provision (Resource Management Amendment Act 1993, ss 60, 116).

[58] Local Government Act 2002, ss 106, 197–206, 209–210.

Most Tier 1 councils levy reserve contributions at two spatial scales. City-wide reserve contributions are generally intended to help fund the provision of new destination parks and reserves – those that residents from across the city may travel to visit. Catchment-specific contributions, in contrast, are intended to help fund the provision of new parks and reserves in the immediate vicinity of new developments.

As shown in Table 3.2, the reserve contributions levied for developments in new greenfield subdivisions vary widely across cities. In Auckland, for example, a new standalone dwelling in the northwest greenfield catchment attracts a reserve contribution of $12,478. The equivalent levy in Wellington's Grenada–Lincolnshire growth area and Christchurch's greenfield growth areas are $2,121 and $1,209, respectively. In part, that divergence probably reflects differences in the price of land – the provision of parks and reserves costs more where land is expensive. It probably also reflects different levels of desired provision – cities with a lot of pre-existing green space may see less need to provide additional parks and reserves.

Reserve contributions for developments in brownfield catchments are typically a fraction of those in greenfield catchments. In Hamilton, for example, a new dwelling created through a two-lot subdivision in the existing urban footprint will trigger a reserve contribution of $333. That same dwelling would trigger a contribution of as much as $6,986 if located in the greenfield Peacocke growth cell. That seems counterintuitive given the difficulty of 'retrofitting' parks and reserves into pre-existing urban fabric, and the fact that land prices in central areas tend to be significantly higher than on the periphery. Certainly, the reserve contributions currently being levied on developments in brownfield areas are nowhere near the 7.5% statutory maximum allowed by the Local Government Act 2002.

In addition to modulating their reserve contributions according to the location of the development, many councils also modulate them according to proposed dwelling size. In Auckland, Hamilton and Tauranga, smaller dwellings (measured either in terms of floor area or number of bedrooms) attract *lower* reserve contributions.[59,60] Presumably, the logic is that smaller dwellings accommodate fewer people, and fewer people translates into less demand for parks and reserves. That logic unravels when the dwellings involved are townhouses or apartments with little (or no) private yard or garden. In that case, demand for parks and reserves may well increase as residents seek public places to connect as kaitiaki, socialise, exercise or get a breath of fresh air.

[59] Auckland Council, 2021, schedule 2.

[60] In Hamilton, for example, a 100% reserve contribution remission is available for apartment buildings of six storeys or more (Hamilton City Council, 2022a, p.30).

**Table 3.2: Maximum reserve contributions levied by selected Tier 1 councils: dollars per household equivalent unit in 2022.[61,62]**

| Council | Reserve contribution (city-wide) | Reserve contribution (brownfield) | Reserve contribution (greenfield) |
|---|---|---|---|
| **Auckland Council** | $4,333 | $5,272 | $8,145 |
| **Hamilton City Council** | $310 | $0 | $6,986 |
| **Tauranga City Council** | $522 | $0 | $6,914 |
| **Upper Hutt City Council** | Financial contribution: 4% | | |
| **Hutt City Council** | Financial contribution: maximum $10,000 | | |
| **Porirua City Council** | $757 | $0 | $10,485 |
| **Wellington City Council** | $553 | $1,922 | $1,568 |
| **Christchurch City Council** | $665 | $616 | $544 |

The reserve contributions shown in Table 3.2 do not provide councils with a lot of purchasing power. Table 3.3 provides an indicative estimate of how much land councils can reasonably expect to purchase with a single reserve contribution.[63]

Again, it is striking how little land the reserve contributions currently being levied on brownfield subdivisions buy. The one or two square metres per new household shown in Table 3.3 falls well short of current provision levels (70–130 square metres per person – see chapter two) as well as the 20 square metres maximum contained in the Local Government Act 2002.

The contributions currently being levied on greenfield subdivisions provide more purchasing power. But, as shown in Table 3.3, much depends on the timing of land acquisition. Greenfield reserve contributions translate into considerably more rural land than land that has already been up-zoned.

[61] Reserve contributions typically vary significantly across catchments. The figures shown in Table 3.2 represent the maximum payable within each city.

[62] Auckland Council, 2021; Hamilton City Council, 2022a; Tauranga City Council, 2022a; Upper Hutt City Council, 2021; Hutt City Council, 2022; Porirua City Council, 2021a; Wellington City Council, 2022b; Christchurch City Council, 2021.

[63] Indicative land prices in brownfield, greenfield and rural areas were estimated using rating valuation data. Three properties were selected from each area (brownfield, greenfield – up-zoned, and rural), and an average of their underlying land values taken.

**Table 3.3: Indicative purchasing power (square metres of land) of an individual reserve contribution.**

| City | Land equivalent ($m^2$) (brownfield) | Land equivalent ($m^2$) (greenfield – up-zoned) | Land equivalent ($m^2$) (greenfield – rural) |
|---|---|---|---|
| **Auckland** | 1.9 | 6.8 | 41 |
| **Hamilton** | 0 | 7.3 | 47 |
| **Tauranga** | 0 | 9 | 38 |
| **Porirua** | 0 | 23.4 | 239 |
| **Wellington City** | 0.5 | 1.4 | 68 |
| **Christchurch** | 0.7 | 1.1 | 13 |

At present, the size, location and characteristics of the public green space to be provided by developers is finalised during the subdivision consent process. In theory, councils can extract whatever level of reserve contribution is specified in their development contribution policy.

The practical reality is more complex, particularly in larger greenfield developments where councils often seek to levy reserve contributions in land rather than money. That requires land valuation, something which introduces uncertainty and, anecdotally at least, often leads to the emergence of a bargaining dynamic between council and the developer. For the developer, the foregone yield associated with setting land aside creates strong incentives to nominate steep undevelopable land, or minimise the area involved. Additional complexity arises in situations where multiple parties have an interest in the development area in question. Trying to equalise the lost development value associated with park provision across all parties is a difficult task, with compromised green space provision as a result.

There is no straightforward solution to these issues. Ultimately though, councils could do more to ensure that their expectations about public green space provision are clearly set out well in advance of decisions about up-zoning. For pocket and neighbourhood sized parks, that may mean being explicit about the *characteristics* of land desired by council. For larger suburb or destination sized parks, which can act as a 'keystone' for residential development to grow around, that may mean being explicit about the *location* of the land desired by council. Establishing such expectations early would ensure that developers incorporate the costs of parks provision into their investment decisions. It would also leave less scope for bargaining and legal challenge when it comes to subdivision consenting.

### The use of development contributions

Not all of the reserve contributions collected by councils are used to create new parks. Some councils also appear to be using them to fund improvements to existing parks.

Details of council spending plans for development contributions can be found in development contribution policies, which are required under the Local Government Act 2002 and must include an inventory of the projects that councils are intending to fund.

In Auckland's case, 55 of the 71 capital projects listed ($607.5 million) concern reserve development – things like new or upgraded facilities (e.g. carparks in parks playgrounds, toilets, lighting or sports turfs – including artificial turf) and new walking and cycling paths. The remaining 16 projects ($587.3 million) related to reserve acquisition in new peri-urban subdivisions.[64] In Christchurch, at least 32 of the 44 capital projects listed ($51.3 million) concerned improvements to existing parks and reserves. The proportion of the remaining 12 capital projects ($77.2 million) that related to acquisition of land for new parks and reserves is unclear.[65]

Prioritising improvements to the existing intra-urban green space network is arguably a pragmatic response to the barriers created by historically high urban land prices. Whether it is a sensible approach in a future likely to be characterised by persistent urban intensification (see chapter four) is more questionable. Demand for parks is only likely to increase as residential density increases and backyard play spaces are replaced by infill development. The extent to which existing parks can cater to increased demand without losing the qualities that make them places of respite will be limited.

But more importantly, choosing not to replace at least some dwindling private green space with additional public green space risks undermining the various environmental services – temperature regulation, stormwater management and biodiversity habitat etc – that urban green spaces provide. That has potentially significant consequences in a future that will be marked by more frequent extreme temperature and rainfall events (see chapter four).

**Development versus financial/environmental contributions**

Financial (or environmental) contributions – which are provided for under the RMA (and the Natural and Built Environment Bill) – offer an alternative way for councils to finance the infrastructure costs of growth. In that respect, they represent a direct substitute for the use of development contributions under the Local Government Act 2002.

At least some councils currently use financial contributions in this way. As highlighted in Table 3.2, for example, Upper Hutt City Council and Hutt City Council use financial contributions to fund parks and reserves. Development contributions are used to provide new water, transport and community infrastructure.

Based on discussions with council staff, the main attraction of that approach is administrative – there are far fewer bureaucratic requirements associated with levying financial contributions. Perhaps the best example of this relates to how funds can be spent. When it comes to development contributions, councils must identify each and every project that funds will ultimately be used to pay for.[66] The test for financial contributions is relatively undemanding: they can only be imposed "in accordance with the purposes specified in the plan or proposed plan …" and where "the level of contribution is determined in the manner described in the plan or proposed plan.[67]

[64] Auckland Council, 2022d.

[65] Christchurch City Council, 2021.

[66] Local Government Act 2002, s 201A.

[67] RMA 1991, s 108(10).

But financial contributions can also be used for a very different purpose: avoiding or mitigating the adverse environmental impacts of development. In particular, they give councils a potentially powerful tool for extracting areas of ecologically sensitive land from greenfield developments. At least some councils formally recognise that possibility. For example, Hamilton City Council's *Draft Open Space Provision Policy* states:[68]

> "In accordance with the Resource Management Act (1991) financial contributions will be considered in situations where development contributions for the same purpose do not apply, and the vesting of land is required to mitigate adverse effects from the development. [This is] particularly relevant where the vesting of land to protect natural resources is required to mitigate adverse effects from development."

Despite the differences in purpose described above, there has been ongoing concern about 'double charging' developers. Amendments made to the RMA in 2017 were intended to address that issue and would have meant local authorities were unable to use financial contributions (for any purpose) from April 2022.[69] Those changes were repealed in 2020, with the Minister of Environment at the time, the Hon David Parker, noting that financial contributions "can be a useful tool to address development impacts".[70] That sentiment has been carried over to the Natural and Built Environment Bill which, as of January 2023, allows environmental contributions to be charged so long as a development contribution is not being charged for the same purpose.[71]

## Public green space within the road corridor

The legal road corridor offers considerable opportunity for green space provision – both in new greenfield areas and in already existing suburbs. Three features of the road corridor are worth noting.

Firstly, it offers opportunities for connecting green spaces into networks in a way that parks and reserves generally cannot.

Secondly, the legal road corridor represents a considerable proportion of the surface area of new subdivisions – and our cities more generally. Analysis undertaken for this report (see chapter two) suggests that proportion varies between 15 and 20% in Auckland, Hamilton and Greater Wellington. It appears to be considerably higher in some of the greenfield areas currently being developed, however. The Warkworth structure plan, for example, sets aside 30% of the total development area for roads.[72]

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[68] Hamilton City Council, 2018, p.17.

[69] In the first reading of the Resource Legislation Amendment Bill, the then Minister for the Environment, Hon Dr Nick Smith, noted that the amendments would "remove the double up of charging regimes between development contributions under the Local Government Act and financial contributions under the Resource Management Act" (New Zealand Parliament, 2015a).

[70] New Zealand Parliament, 2019.

[71] Natural and Built Environment Bill, clause 239.

[72] Auckland Council, 2019, p.107.

Thirdly, roads are already publicly owned, so retrofitting green space into them does not require the purchase of new land. The road network created in new residential developments is vested in councils on completion of the subdivision process. Councils can determine the size, shape and 'greenness' of the roads that are transferred to them through the conditions they impose on subdivision consents. In general, council expectations in this regard are set out in district plans and subdivision codes of practice, both of which tend to draw on best practice design guides.[73] NZS 4404:2010 – Land Development and Subdivision Infrastructure, for example, specifies that residential roads should have a total legal width of 20 metres, with two 3-metre traffic lanes, two 2.5-metre parking lanes, two 1.4-metre footpaths, and two 3.1-metre berms.[74]

There is considerable variation in the requirements for vegetated street berms across councils. The Hamilton City District Plan, for example, requires local roads in residential areas to have a 7-metre berm on each side. These must provide space for two 2-metre-wide recessed car parking bays, two 2-metre-wide footpaths, and two 1.5-metre-wide (infrastructure) service corridors. Little mention is made of vegetation or street trees, although it is noted that (when required) these will "typically replac[e] indented parking or medians".[75]

The situation in Porirua is different. In the notified Porirua City Proposed District Plan, a single "street tree berm" of at least three metres wide is required to be provided on all new or upgraded urban roads.[76,77] There are also standards setting out how these berms are to be planted. For example, a minimum of eight trees per 1,000 square metres of road reserve must be planted in new residential areas – around one tree for every six metres of road length, where the planted trees have a height of eight metres at maturity and a stem diameter of less than 300 millimetres at 1.5 metres above ground. The number of trees required is dependent on the size class at maturity, with larger trees requiring fewer to be planted.

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[73] These include the Waka Kotahi *One Network Framework and Urban Street Planning and Design Guide*, Standards New Zealand's *Land Development and Subdivision Infrastructure Standard* (NZS 4404:2010), and Austroad's *Guide to Road Design*.

[74] Johnstone, 2010, p.13.

[75] Hamilton City District Plan, Appendix 15 – Transportation.

[76] These provisions are currently proposed and are subject to decisions from an Independent Hearings Panel due in 2023.

[77] Porirua City Proposed District Plan, Part 2 – Infrastructure.

Source: PCE

**Figure 3.2: Adjoining roads without and with berms shaded by large trees in Strathmore, Wellington.**

While the road corridor appears to be an excellent candidate for urban greening, there are several barriers that often get in the way.

The many competing claims on the road corridor is one such barrier – retaining or setting aside space for vegetation almost inevitably impinges on other uses. Car parking is one example. The Government's recent decision to prohibit councils from requiring off-street parking in new developments will, in the short term at least, probably mean more cars parked in the road corridor.[78]

[78] NPS-UD, s 3.38.

The tendency of trees to interfere with and potentially damage network utilities (e.g. three waters pipes and above-ground power lines) is another example.[79] It has resulted in planning rules that restrict the species and location of trees planted in the road corridor or require the use of 'tree pits' – underground cages designed to ensure tree roots remain within a pre-determined area. One solution to this is to simply increase the width of the road corridor, but that comes with its own trade-offs. Another solution is to locate infrastructure trenches under the road (rather than berm) and to combine complementary infrastructure in single continuous conduits.

The cost of maintaining vegetation represents another barrier to greening the road corridor. Some of the developers spoken to during the course of this investigation highlighted instances where they had sought to exceed council expectations for vegetated berms, only to be told that maintenance would be too expensive in the long term.

One solution that has emerged in response to council concerns about maintenance costs is a delayed vesting process, whereby the council requires the developer (or a residents' association) to retain responsibility for maintaining street vegetation for an extended period. Another is the use of targeted rates, whereby households in developments with greater endowments of street vegetation contribute to the ongoing costs of maintaining it.[80]

Finally, in addition to the above, concerns about road safety and public perceptions of untidiness can also represent material barriers to revegetating the road corridor.

## Esplanade strips and reserves

Esplanade strips and reserves are thin slices of land situated alongside the coast, lakes, streams and rivers. According to the RMA, their purpose is (i) to contribute to the protection of conservation values, ii) to enable public access to or along any sea, river, or lake, or (iii) to enable public recreational use where the use is compatible with conservation values.[81]

There are important differences between esplanade reserves and esplanade strips in terms of ownership and access. In terms of ownership, esplanade reserves vest in the territorial authority upon the issue of new titles.[82] By contrast, esplanade strips are created by a legal instrument registered on the title of the property, with ownership of the strip remaining with the landowner. When it comes to access, the general presumption is that esplanade reserves are always available for public use. The same is not necessarily true of esplanade strips, which can be closed to the public during specific times and periods.[83]

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[79] Such conflicts are frequent. Vector – the primary electricity distribution company in Auckland – plants two trees in Puhinui Regional Park for every tree it removes to protect Auckland's powerlines. In 2018 and 2019, 31,000 trees were planted – implying that around 15,000 were removed from Auckland's roads (Vector, 2018).

[80] Residents in Tauranga's Lakes development, for example, pay an additional $103 per year for the purpose of "maintaining and renewing street gardens, paths, trees and ponds" (Tauranga City Council, 2022f, p.33).

[81] RMA 1991, s 229.

[82] RMA 1991, s 231.

[83] RMA 1991, s 237C.

The RMA gives territorial authorities powers to require that esplanade strips or reserves be set aside when land bordering the sea, a lake or a river is subdivided. In general, the presumption is that esplanade reserves and strips will be 20 metres in width, although councils can opt to waive, increase or reduce this through rules in their district plans or a resource consent.[84] The 20-metre value has its origins in the concept of the 'Queen's Chain'. It has real historical resonance as something that can be expected and is therefore harder to ignore than some other policy requirements.

Perhaps most importantly, for subdivisions that result in allotments of less than four hectares (i.e. the vast majority of those in peri-urban settings), no financial compensation is due to landowners if esplanade reserves or strips of 20 metres or less are taken.[85] That makes esplanade strips and reserves a powerful tool for councils seeking to set aside natural areas or create ecological corridors as greenfield development proceeds.

## Other pathways for creating public green space

Not all public green space in cities is created as part of the subdivision process. In theory at least, councils can acquire land with the intention of setting it aside as a park, reserve, greenbelt, stormwater reserve or sports ground at any time. Glover and Midland Parks in central Wellington owe their existence to this process.[86] So does Barry Curtis Park in Auckland (Figure 3.3), and much of the land that now makes up Wellington's Outer Green Belt (see Box 3.4).

Source: Look Up Look Down Photography, Unsplash

**Figure 3.3: Barry Curtis Park, Flat Bush, Manukau City is one of the largest urban parks to be built in New Zealand in recent decades. The park was created on dairy farming land identified by Manukau City Council in the late 1990s.[87] The first stage of the park opened in 2009, with completion due in 2022.[88]**

[84] RMA 1991, s 77 and s 230(3).

[85] RMA 1991, s 237E(1).

[86] Wellington City Council, 2005; Martyn, 2011.

[87] Curtis: Opening event at Barry Curtis Park | Scoop News

[88] See https://isthmus.co.nz/project/barry-curtis-park/ and https://en.wikipedia.org/wiki/Barry_Curtis_Park.

**Box 3.4: The creation of Wellington's Outer Green Belt**

The Outer Green Belt is a roughly 30-kilometre-long corridor of largely regenerating bush that defines the western edge of Wellington City. It comprises 3,029 hectares of public land, most of which has been acquired by Wellington City Council over the last 40 years.[89]

The idea for an Outer Town Belt emerged in the mid-1970s, partly as an antidote to the urban sprawl that had occurred during preceding decades. In addition, there was a desire to replicate the Wellington Town Belt, which had been a considerable source of public enjoyment for inner-city dwellers.[90] *Preserving Wellington's Open Space*, a document published by Wellington City Council in 1976, described the original intent as follows:

> "Several connector links are required to form a continuous green belt or outer town belt encircling the outer city suburbs from Brooklyn and Karori north to Johnsonville and Churton [Park]. These links will enable the retention of the skyline surrounding the suburbs, the protection of local features such as Makara High, the formation of a walkway system surrounding the city and possibly in later years, a scenic drive, and a segregation between housing and rural land uses".[91]

Since at least the early 1980s, Wellington City Council has sought to buy land for the Outer Green Belt whenever opportunities have arisen. Initially, the focus was on connecting land already in council ownership: Johnston Hill, Ōtari-Wilton's Bush and Khandallah and Johnsonville Parks.[92] Over time, that focus has gradually expanded to the north and south with the intention of having continual public open space along the ridges from the northern city boundary to the south coast. Recent purchases have included 32 hectares of plantation forestry immediately west of Tawa ($1.1 million) and 31 hectares of pastoral land west of Churton Park.[93]

Not all the focus has been on outright land acquisition. Wellington City Council has also sought to facilitate public access and protect landscape and biodiversity values by working collaboratively with other landowners. Access to the peak of Mount Kaukau, for example, is made possible through an agreement with Kordia – a state-owned technology company.

In parallel, Wellington City Council has imposed zoning rules to manage development on identified prominent landforms and landscapes in the city to protect the relatively undeveloped character and other open space values of those areas. Some of the identified areas overlay parts of the Outer Green Belt as well as adjacent private land. The Ridgelines and Hilltops Overlay, for example, seeks to "control the construction and siting of new buildings, structures and earthworks on identified ridgelines and hilltops".[94]

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89 Wellington City Council, 2019, p.21.
90 Wellington City Council, pers. comm., 5 December 2022.
91 Wellington City Council, 2019, p.219.
92 Wellington City Council, 2019, p.219.
93 Devlin, 2017; Wellington City Council, 2019, p.105.
94 Wellington City Council, 2022c.

There is little doubt that the rugged and infertile character of Wellington's hill country has been a key factor in the creation of the Outer Green Belt. Relative to the peri-urban margins of New Zealand's other major cities, there are fewer alternative land uses available, with lower land prices as a result. That said, by coupling an ambitious acquisition policy with consistent funding over the long term, Wellington City Council has taken full advantage of that opportunity.

Elsewhere, councils' ability to acquire land for new parks and reserves outside the subdivision process is hindered by a range of factors.

Perhaps most obviously, there is no guarantee that owners of land that a council wishes to buy will be willing to sell. In peri-urban settings, there may be strong incentives *not* to sell. As long as councils avoid identifying open space needs in advance of rezoning decisions, it is worth landowners' while to wait for up-zoning and the value uplift associated with it.

When it comes to other types of infrastructure – roads, for example – it is clear that the issue can be dealt with through the use of acquisition powers available under the Public Works Act 1981. However, it is ambiguous whether councils can use these powers to acquire land for new parks and reserves. The Public Works Act neither explicitly includes nor excludes this possibility. The issue hinges on whether a park or reserve can be considered a 'local work'. In cases where some kind of positive act is required to transform the land into a 'park', there is a strong argument that the Public Works Act can be used. In other situations that involve less positive action – acquiring reserve land to protect natural values, for example – the argument is more tenuous.

Different councils have different interpretations. Auckland Council's *Parks and Open Space Acquisition Policy* explicitly states that the Public Works Act "provides Auckland Council with the ability to compulsorily acquire land for parks and open space".[95] It further notes that parks and open space "are a form of public work" for the purposes of the Public Works Act.[96] Wellington City Council is more cautious and does not generally invoke the Public Works Act to acquire land for parks and reserves.[97] That is probably not surprising. Using compulsory acquisition to secure land for a service that councils are not strictly required to provide raises the risk of legal challenge.

In most cases then, councils seeking to acquire land for new parks and reserves (outside the subdivision process) wait until market opportunities emerge. That often means engaging in a competitive open-market process with other potential buyers. Councils are not always well-placed to compete – the need to ensure that spending decisions are made responsibly and openly can make submitting an offer within the required time frame difficult. One solution to that is the creation of strategic land acquisition funds – created as part of the long-term plan process but without any specific parcels of land earmarked against them. Wellington City's inner-city parks fund is one example of this.[98]

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[95] Auckland Council, 2013, p.8.

[96] Auckland Council, 2013, p.11.

[97] Wellington City Council, pers. comm., 22 August 2022.

[98] Wellington City Council, 2021a, p.183.

The upfront cost of the land required is also a major barrier to the provision of new parks and reserves. Funds raised from development contributions can help, but these are only intended to meet additional demand associated with growth. Development contributions are not well-suited to filling already existing gaps in a city's endowment of parks and reserves. For councils seeking to materially increase the availability of public green space, that leaves few options other than an increase in borrowing, with the associated rates increases required to service it. The challenges – political and otherwise – that councils face funding infrastructure by these means are well documented (see the section on 'infrastructure provision' above).

In the context of green infrastructure such as parks and reserves, the challenge is compounded by the fact that – unlike traditional infrastructure such as pipes and roads – there is no top-down requirement for councils to provide it. According to a number of park planners and managers spoken to during the course of this investigation, this lack of guidance tends to mean that green infrastructure is treated as a discretionary 'nice to have' when hard decisions about how to allocate spending in long-term plans are made.

The idea that council investment in traditional infrastructure is prioritised over that in green infrastructure is largely supported by published spending plans. As shown in Table 3.4, most Tier 1 territorial authorities plan to spend around 0–10% of their capital budget on parks and reserves over the next ten years.[99] In contrast, planned capital spending on three waters or transport infrastructure each generally amounts to 20–40% of the capital budget.

[99] Some councils appear to be planning to spend considerably more, but that is largely an artefact of the categories that spending is divided into. In Upper Hutt, for example, the 'community and recreation' category includes projects like earthquake strengthening for the Civic Centre and the creation of a new 'Community Hub' office space.

**Table 3.4: Breakdown of planned capital spending in long-term plans, 2021–2031.**

| Council | Total CAPEX | Parks and reserves | | Three waters | | Transport | |
|---|---|---|---|---|---|---|---|
| | $ million | $ million | % of total | $ million | % of total | $ million | % of total |
| **Auckland Council** | 31,800 | Not provided | | 11,137 | 35% | 12,645 | 40% |
| **Hamilton City Council** | 2,448 | 198 | 8% | 873 | 36% | 1,014 | 41% |
| **Tauranga City Council** | 4,644 | 618 | 13% | 1,655 | 36% | 1,976 | 43% |
| **Upper Hutt City Council** | 359 | 121 | 34% | 100 | 28% | 138 | 38% |
| **Hutt City Council** | 1,454 | 85 | 6% | 587 | 40% | 406 | 28% |
| **Porirua City Council** | 785 | 31 | 4% | 536 | 72% | 135 | 18% |
| **Wellington City Council** | 3,216 | 74 | 2% | 679 | 21% | 1,050 | 33% |
| **Christchurch City Council** | 5,787 | 645 | 11% | 1,912 | 33% | 1,448 | 25% |

Note: CAPEX = capital expenditure

The cost of parks provision is not limited to upfront land and development costs. As discussed, there are recurring costs associated with mowing, weeding, pest management and tree pruning.

There is nothing particularly novel about this. Other forms of infrastructure – roads and pipes, for example – also have a maintenance bill attached to them. The difference is that councils do not typically cite that bill as a reason to minimise the quantity – or quality – of the infrastructure in question. That said, as noted above, councils have little discretion in the matter when it comes to roads and pipes.

Table 3.5 summarises councils' intended operational spending on parks and reserves, three waters and transport infrastructure over the next ten years. Most councils are planning to spend around 10% of their operating budget on maintaining parks and reserves – similar or slightly less than for transport, and significantly less than for three waters infrastructure.

Disaggregated data on how councils spend their parks and reserves operating budget are unavailable. However, given that much of the public green space in New Zealand cities is grass (see chapter two), it seems likely that mowing accounts for a significant fraction of the budget.[100] Provision of tree canopy cover is an effective method to suppress grass growth and reduce mowing frequency while adding a greater range of ecosystems services and other benefits.[101]

[100] Historically at least, parks and reserves management has centred around the mowing and marking of public parks and sports facilities. That is neatly captured by the phrase – heard several times during the course of this investigation – "If we can't mow it, we don't want it."

[101] Simcock, 2014; Ira and Simcock, 2019.

**Table 3.5: Breakdown of planned operating spending in long-term plans, 2021–2031.**

| Council | Total OPEX | Parks and reserves | | Three waters | | Transport | |
|---|---|---|---|---|---|---|---|
| | $ million | $ million | % of total | $ million | % of total | $ million | % of total |
| Auckland Council | 36,695 | Not provided | | 4,396 | 12% | 12,173 | 33% |
| Hamilton City Council | 3,659 | 390 | 11% | 1,120 | 31% | 849 | 23% |
| Tauranga City Council | 3,227 | 636 | 20% | 1,036 | 32% | 548 | 17% |
| Upper Hutt City Council | 897 | Not provided | | 332 | 37% | 155 | 17% |
| Hutt City Council | 1,984 | 159 | 8% | 574 | 29% | 241 | 12% |
| Porirua City Council | 1,525 | 160 | 10% | 398 | 40% | 105 | 10% |
| Wellington City Council | 5,637 | 542 | 10% | 1,004 | 18% | 514 | 9% |
| Christchurch City Council | 10,311 | 857 | 8% | 2,884 | 28% | 1,867 | 18% |

Note: OPEX = operating expenditure

## Central government as a provider of public green space

Local government is not the only provider of public green space in New Zealand cities. Central government is also important, whether in its role as a provider of education (Ministry of Education), roading (Waka Kotahi), parks (Department of Conservation), or housing (Kāinga Ora).

School grounds are a particularly important part of the public green space network. They are common in most suburban areas and are generally available for public recreational use outside of school hours.[102] Like any other large urban green space, school grounds also have the potential to provide significant environmental services.

The Ministry of Education has published design standards that guide and, in some cases, prescribe the physical layout of new schools. *Designing Schools in Aotearoa New Zealand* includes specific recommendations about the number of sports fields and amount of "useable outdoor area" that should be provided.[103] In both cases, however, compliance with these recommendations is voluntary – discretion can be exercised where school sites are "constrained" or "highly constrained". Somewhat circularly, the definition given for a constrained site is one that has a "limited amount of useable outdoor area per learner".

[102] Decisions about after-hours access to schools are generally made by Boards of Trustees (Ministry of Education, no date). Data on the proportion of schools that allow after-hours access are scarce, although a recent survey of primary schools in Wellington City suggests the number may be as high as 93% (Wellington City Council, 2017, p.7). After-hours public access is not universal, however. Health and safety concerns appear to be a key consideration where it is restricted (Rankin, 2017).

[103] Ministry of Education, 2022.

*Designing Schools in Aotearoa New Zealand* notes that highly constrained sites "may require bespoke solutions for access to active recreation space".[104] While not explicitly identified, the shared use of council-provided open space offers a potential solution.[105] For both councils and the ministry, there are potentially significant cost savings associated with increased collaboration on open space provision. But, as highlighted by a number of individuals spoken to during the preparation of this report, this comes with wider risks – particularly if both parties seek to rely on the other's open space endowments to absolve them of their own responsibilities.

Another concern raised during the preparation of this report was the slow but persistent consumption of school fields as school rolls grow and new classrooms are built. While the scale of this phenomenon is difficult to quantify, it is readily observable through visual comparison of historical aerial photographs. *Designing Schools in Aotearoa New Zealand* prioritises "compact and efficient occupation of land" as a priority for school designers, and identifies multilevel buildings as "the preferred solution for constrained sites".[106] Such approaches make good sense, although how widely they are being applied is far from clear.

## Private green space: the influence of planning rules on land use decisions

### District plans

The planning policies and rules contained in district plans are a major determinant of the fabric of New Zealand's residential areas and, therefore, the distribution of privately owned green space within them.

In general, district plan rules do not target the provision of private green space directly. Instead, the distribution of private green space in residential areas is shaped by rules governing the built form: minimum allotment size, number of buildings per site, maximum built coverage outlook space and maximum impervious area, for example. Private green space falls out as a residual.

Table 3.6 summarises the plan provisions for the main 'standalone' residential zone of New Zealand's major cities. As of June 2022, and with the notable exception of Auckland,[107] this zone accounted for the majority of residentially zoned areas. While that is no longer the case (due to the implementation of the MDRS – see the section on 'national direction' below), these rules are a major reason why New Zealand cities have the residential fabric they do today.

[104] Ministry of Education, 2022, p.31.

[105] Ministry of Education, 2018; Wellington City Council, 2017, pp.28, 42.

[106] Ministry of Education, 2022, pp.18, 36.

[107] Auckland's mixed housing urban and mixed housing suburban zones – both of which allow for the construction of three dwellings as a permitted activity – accounted for ~70% of all residentially zoned areas as of June 2022 (PCE analysis).

**Table 3.6: Rules relating to the construction of new dwellings as a permitted activity in standalone residential zones, June 2022.[108]**

| City | Maximum dwellings as a permitted activity | Minimum lot size | Maximum built coverage | Maximum impervious area | Minimum landscaped area |
|---|---|---|---|---|---|
| **Auckland (SHZ)** | 1 | No | 35% | 60% | 40% |
| **Hamilton (GRZ)** | 1 | 400 $m^2$ | 40% | 50–70% | No |
| **Tauranga (SRZ)** | 1 | 325 $m^2$ | 45–55% | No | No |
| **Upper Hutt (RZ)** | 1 | 400 $m^2$ | 35% | No | No |
| **Lower Hutt (GRZ)** | 2 | No | 40% | 70% | No |
| **Porirua (GRZ)** | 1 | No | 40% | No | No |
| **Wellington City (ORZ)** | 3 | No | 35–40% | No | No |
| **Christchurch (RSZ)** | 2 | 450 $m^2$ | 35% | No | 20% |

Notes: SHZ = single house zone; GRZ = general residential zone; SRZ = suburban residential zone; RZ = residential zone; ORZ = outer residential zone; RSZ = residential suburban zone.

Several insights emerge from Table 3.6. First, all of the district plans assessed contain standards describing the proportion of a site that can be built upon. While the purpose of these provisions is generally to promote residential built character,[109] they also help to preserve privately owned green space. The plans assessed limit the proportion of a site that can be built upon as a permitted activity to between 35 and 55%. That said, in many cases, built coverage does not include decks, terraces, carports or pools, meaning the proportion of a site covered by structures can be higher in practice.

Second, some of the district plans assessed contain standards describing the proportion of a site's area that can be sealed. While the purpose of these standards is to help manage stormwater flows, they also help to preserve green space on residential sites. Auckland Council, Hamilton City Council and Hutt City Council allow up to 60–70% of sites in standalone residential areas to be sealed as a permitted activity. Recent monitoring undertaken by Auckland Council, however, indicates that impervious coverage standards are being exceeded in almost a third of new developments.[110] Furthermore, that figure does not take into account the post-development reduction of green space associated with unconsented driveway, patio or pool extensions. Anecdotally at least, the cumulative effect of these changes can be large.

[108] PwC and Sense Partners, 2022, Appendix B; PCE analysis.

[109] For example, the Auckland Unitary Plan identifies "achiev[ing] the planned suburban built character of buildings" as the purpose of building coverage rules. Similarly, the Wellington District Plan notes that over-development of a site creates the risk of "adverse amenity effects for adjoining neighbours", and promotes site coverage rules as the main tool to address this.

[110] Auckland Council, 2022c, p.94.

Not all councils use impervious coverage standards to mitigate the stormwater impacts of development. Instead, many rely on district-wide hydraulic neutrality requirements. Effectively, any proportion of development sites can be sealed so long as the stormwater leaving them is no greater than the pre-development baseline. For smaller sites, this is generally achieved through on-site tank storage,[111] although green roofs or raingardens can also help.[112] For larger development areas, the creation of engineered wetlands or detention/infiltration basins may be required.

Third, some plans have specific rules relating to private green space – or 'landscaped area' – that must be provided. In Auckland's case, building a new dwelling in the single house zone is a permitted activity if, among other things, at least 40% of the site area is retained as landscaped area. The equivalent figure in Christchurch is 20%. Notably, Christchurch City Council requires half of that area to be planted in shrubs and trees, with a minimum of one tree for every 250 square metres of site area.

Regardless of the exact provisions contained in district plans, very little of the residential development currently taking place in New Zealand cities preserves much private green space. That is certainly true of two- or three-lot subdivisions in already built-up urban areas. The creation of an additional dwelling (and driveway to service it) on a front or rear lot almost inevitably leaves little space for a yard, garden or trees.

It is also true of the medium-density developments that have become increasingly popular in recent years. As discussed in chapter two, townhouse and terraced housing developments in places like Hobsonville Point and Takanini typically set aside less than 20% of individual lots as yard or garden. As shown in Figure 3.4, even recent greenfield developments dominated by standalone housing are not particularly green.

[111] Wellington Water, 2022.

[112] Auckland Regional Council, 2010.

Source: LINZ Data Service[113]

**Figure 3.4: Private green space availability in recent standalone style greenfield developments: Karaka, Auckland (top); Flagstaff, Hamilton (centre); and Trentham, Upper Hutt (bottom).**

[113] Aerial imagery sourced from the LINZ Data Service and licensed by Auckland Council and AAM NZ Limited (Karaka), Hamilton City Council (Flagstaff), and Upper Hutt City Council (Trentham) for reuse under CC BY 4.0.

District plan rules also have an impact on individuals, whānau, hapū and iwi who live within city limits while also trying to exercise their tikanga and kaitiakitanga. To provide for their social, cultural and economic wellbeing, Māori have in some areas worked with councils to create unique provisions like papakāinga and Māori purpose zones. Others have developed their own Māori land or land retained through the Treaty settlement process for those same purposes. Some of these areas allow for communal living where a range of residential and non-residential activities are allowed, including marae. Importantly, there is provision to create green spaces that provide for the inclusion of Māori values like kaitiakitanga, mahinga kai, customary activities and rongoā, and incorporate mātauranga and tikanga in their design.[114]

Mana whenua involvement in plan making creates opportunities to ensure that unique Māori identities and values are reflected in regional and district plans. Plans developed using tikanga and kaitiakitanga have the potential to shift current thinking of green space availability and quality from a 'nice to have' to a necessity when designing urban areas. Box 3.5 provides an example of the sorts of outcomes that can be achieved when councils and mana whenua work together on plan development.[115]

**Box 3.5: The Kākātangiata greenfield development area in Palmerston North**

Since 2020 Palmerston North City Council and Rangitāne o Manawatū have been developing the Kākātangiata masterplan as part of a plan change process to achieve the council's future housing needs.[116] The 840-hectare greenfield site is on the western edge of Palmerston North.

The Kākātangiata masterplan sets aside 20% of the total development area for public green space, largely along waterways like Mangaone Awa and Awapuni Lagoon (historically an oxbow lake). The green spaces are intended to be multifunctional and will include conventional parks and reserves; easily accessible walkways; stormwater retention services in the form of wetlands; biodiversity corridors, including connection to an old remnant kahikatea forest; and natural hazard mitigation opportunities.

Rangitāne o Manawatū have been involved in the creation of the masterplan from the outset and have been integral in the design of the area, taking a te ao Māori approach and using the Whānau Ora Outcomes Framework. The result is a design that is intended to work with the landscape rather than against it, improve the services already present in the landscape, include aspirations for the area that Rangitāne o Manawatū have historical connections to and articulate their kaitiakitanga goals. For example, the iwi are able to harvest harakeke to make piupiu and improve the mauri of the wai.

Active involvement for Rangitāne o Manawatū was supported by an already established long-term relationship with Palmerston North City Council, the use of Māori frameworks such as the Whānau Ora Outcomes Framework, and the utilisation of work done during the Treaty settlement process that allowed Rangitāne o Manawatū to articulate the importance of their traditional village and pā sites, and mahinga kai sites in the old Awapuni Lagoon.

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[114] See for example Christchurch City Council, 2022a, chapter 12; Napier City Council, no date; Auckland Council, 2022b, chapter H27.

[115] Rangitāne o Manawatū and Kahu Environmental, pers. comm., 5 December 2022.

[116] The Kākātangiata urban growth plan change is in development; it has not been publicly notified and may be subject to change. The council is currently working to establish how implementation of the plan change can occur most effectively and efficiently to deliver the outcomes identified in the masterplan prior to notification.

## National direction exerts a strong influence on planning rules

The provisions discussed in the previous section have emerged from the processes of local government decision making over many years.

Recently, central government has become more involved in this process through two instances of national direction: the NPS-UD and the MDRS.[117] Both are responses to the rapid increase in house prices that occurred between 2013 and the end of 2021 and are intended to improve housing affordability by requiring councils to increase the supply of land zoned for denser forms of development – primarily in already built-up areas.

The NPS-UD was first published in 2020. Among other things, it requires Tier 1 councils to enable building heights of at least six storeys within metropolitan centre zones and a "walkable catchment" of (i) existing and planned rapid transit stops, (ii) the edge of city centre zones, and (iii) the edge of metropolitan centre zones.[118] Territorial authorities were required to notify the proposed plan changes needed to give effect to the intensification provisions by August 2022.

The MDRS were incorporated into the RMA in December 2021.[119] In short, they require Tier 1 territorial authorities to enable up to three dwellings of up to three storeys to be built 'as of right' (i.e. without resource consent) on most residentially zoned sites. All that is required is for a set of 'density standards' to be met. The most important of these in the context of this report are:

- **Building coverage**

  Building coverage must not exceed 50% of the net site area.

- **Landscaped area**

  A minimum of 20% of the site must be landscaped with grass or plants. This can include the area covered by tree canopy regardless of the nature of the surface beneath.

The absence of a standard relating to impervious area is notable given that the original Bill proposed maximum impervious site coverage of 60%. According to the Environment Committee report that accompanied the Bill, it was decided that stormwater should be "dealt with as a district-wide matter for councils to determine".[120] In practice, that meant that councils had an opportunity to amend their existing stormwater rules as part of the plan change required to implement the MDRS. Some councils appear to have done that. Auckland Council and Tauranga City Council included maximum impervious coverage standards of 60% and 70% in their proposed plan changes, for example.[121]

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[117] The MDRS were incorporated into the RMA in late 2021 – see ss 77G to 77T.

[118] NPS-UD, policy 3.

[119] By way of the Resource Management (Enabling Housing Supply and Other Matters) Amendment Act.

[120] Environment Select Committee, 2021, p.13.

[121] Auckland Council, 2022h, p.104; Tauranga City Council, 2022d, p.9.

Because they apply to all residentially zoned areas, the MDRS are potentially more consequential (both for housing supply and green space) than the NPS-UD requirements (Box 3.6). That said, the actual impact will depend on market dynamics as well as the extent to which councils seek to carve out particular areas from up-zoning on the basis of 'qualifying matters' identified in the Act. The proposed plan changes notified by some councils (Auckland Council and Hamilton City Council, for example) identify concerns about infrastructure capacity and the loss of special character as a reason to exclude significant areas from up-zoning. It remains to be seen (as of October 2022) whether those decisions survive the scrutiny of the hearing processes that will follow.

**Box 3.6: NPS-UD versus MDRS: relative environmental merits and likely market uptake**

The primary focus of both the NPS-UD and the MDRS is to improve housing supply within the existing urban footprint. The NPS-UD does that by promoting development upwards, while the MDRS focus on development inwards. If reducing transport emissions and congestion is the goal, then both of those strategies are almost certainly preferable to development outwards.

When it comes to green space, outcomes from the NPS-UD and MDRS are likely to be quite different. While multi-storey apartment buildings and low-rise terraced housing both tend to consume much of the green space available at individual sites, apartments do so while providing many more dwellings. All else being equal, that means less pressure to develop green space elsewhere in the city, but more recreational demand on pre-existing nearby parks.

In the long term, the green space implications of the Government's push for intensification will depend on the relative uptake of the NPS-UD and MDRS. Council decisions will be an important factor in this, but so will market dynamics.

There are a number of reasons why the townhouses and terraced housing promoted by the MDRS might emerge as a market winner. Most obviously, no resource consent process – or public notification – is required to build them. For developers, that translates into time and cost savings. Townhouses are also less technically demanding and capital intensive to build, and there is very likely a smaller pool of developers with the resources to attempt larger, more complex multi-storey apartments. Furthermore, townhouses and terraced houses typically come without body corporate arrangements – something which, anecdotally at least, can be a barrier to demand for apartment living.

The housing development enabled by the NPS-UD and MDRS will make increased claims on a range of existing infrastructure. The Government has recognised that by requiring councils to provide enough development infrastructure to service expected growth (via the NPS-UD) and allocating funding (via the Housing Acceleration Fund) to help councils do that. No such consideration appears to have been made for public green space. That is surprising given that the aim of both policies is allegedly to improve urban wellbeing, both now and in the future, and to do so in a way that is resilient in the face of expected climate change.

## How urban green space (and vegetation) is protected

There are a number of legislative safeguards that restrict the disposal of urban green space, as well as the removal of vegetation growing on it. Recent housing pressures have, however, seen the creation of increasingly inventive 'work arounds'. In some cases, such as tree protections, the safeguards themselves have been watered down.

The disposal of urban green space is not always a bad thing. The money generated from the sale of publicly owned green space can be used to improve the quality of existing parks. Alternatively, it can be used to purchase land for new parks and reserves in suburbs that, for historical reasons, have lacked them. However, there is an ever-present risk that the proceeds from park sales are instead used to generate revenues and shore up public balance sheets.

### Bespoke legislative protections for parks and reserves

A number of public parks were created – and are protected – by bespoke Acts of Parliament. For the most part, these statutes relate to large areas of open space that were set aside early in the development of New Zealand's cities.

Perhaps the best-known example is the Wellington City Reserves Act of 1871. This granted ownership of Wellington's town belt to the Superintendent of the Province "for purposes of public utility to the Town of Wellington and its inhabitants".[122] The recently updated version of this Act – the Wellington Town Belt Act 2016 – requires Wellington City Council to "recognise and provide for the protection and enhancement of the Wellington Town Belt for future generations".[123] With the exception of instances where public works are involved, the Act also prohibits the removal of land from the town belt.[124]

Similar legislation was passed during the early development of other cities. In Christchurch, the transfer of Riccarton Bush from the Deans family to the people of Christchurch was accomplished via the Riccarton Bush Act 1914. Several conditions were included in this statute, including a requirement that the land "be used and kept for all time for the preservation and cultivation of trees and plants indigenous to New Zealand".[125]

Auckland Domain owes its existence to similar arrangements. Having been acquired by the Crown (along with much of what became central Auckland) from Ngāti Whātua Ōrākei, the land was set aside as a public reserve in 1843.[126] In 1893, the land comprising Auckland Domain was transferred to the City of Auckland and its citizens via the Auckland Domain Vesting Act. The Act states that the land "shall be held … as a place of public recreation and enjoyment for the inhabitants of the Borough of the City of Auckland and the public generally".[127]

While statutory protections of this sort are difficult to reverse, they have not been immune from recent attempts to make more land available for housing (Box 3.7). The underlying rationale is often that the land is 'underutilised' for recreational purposes and could be put to 'better' uses if developed.

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[122] Wellington City Reserves Act 1871, preamble.
[123] Wellington Town Belt Act 2016, s 4(1).
[124] Wellington Town Belt Act 2016, s 22.
[125] Riccarton Bush Act 1914, preamble.
[126] Waitangi Tribunal, no date.
[127] Auckland Domain Vesting Act 1893, s 6.

**Box 3.7: Using bespoke legislation to override historical park protections**

In recent years, Parliament has passed local bills that undo pre-existing legal protections for inner-city parks. The objective has typically been to improve housing affordability by increasing the supply of developable urban land.

The Riccarton Racecourse Development Enabling Act 2016 is one example. It allowed 40 hectares of open space protected by the Christchurch Racecourse Reserve Act 1878 to be sold for residential development. In the first reading of the Bill, the then Minister for Building and Housing, Hon Dr Nick Smith, noted that "it is exactly the kind of location where new housing is needed, and I put it to the House that to have this land underutilised, sitting vacant, is actually not the best use of this country's resources".[128]

The Palmerston North Reserves Empowering Amendment Act 2022 is another example. It allows two hectares of land protected by the Palmerston North Reserves Empowering Act 1966 to be sold and used for housing. The land in question – known as Huia Street Reserve – was previously used by a lawn bowls club. In the consultation document that preceded the introduction of the Bill, the Palmerston North City Council noted that the land "had been vacant since 2005" and "is not required … to meet any community or recreation needs".[129]

In both the above cases, the sale and subdivision of public land was justified by a perception that that the land in question was underutilised. What level of utilisation would be required for these parks to have remained in public ownership is unclear. Regardless, direct recreational use is not the only benefit that public green space provides. There is little evidence that the various ecosystem services outlined in chapter one were given any consideration during the decision-making process.

## Protections for parks and reserves under the Reserves Act

Regardless of how it was acquired, a local authority can choose to declare land vested in it as a reserve under the Reserves Act 1977.[130]

The Reserves Act classifies reserves into eight categories, many of which have their origin in legislation from the late 1800s. These categories are national reserves, recreation reserves, historic reserves, scenic reserves, nature reserves, scientific reserves, government purpose reserves and local purpose reserves. Under the Act, local authorities can decide – subject to public notification – which of these categories is most appropriate for a particular parcel of land.[131] This has implications for how the future reserve is managed as well as the process required to dispose of it.

Land with reserve status cannot be sold or otherwise disposed of. Councils seeking to do so must first revoke that status using a process set out in the Reserves Act. The exact requirements vary according to the type of reserve involved.[132]

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[128] New Zealand Parliament, 2015b.

[129] Palmerston North City Council, 2019, p.4.

[130] Reserves Act, s 14.

[131] Reserves Act, s 14.

[132] The least stringent requirements relate to government purpose and (some) local purpose reserves, where revocation only requires prior approval of the Minister of Conservation. In contrast, the reserve status of nature and scenic reserves cannot be revoked unless public notification has been given, and the Minister is "satisfied that the reserve is no longer suitable for the purposes of its classification because of the destruction of its forest, bush, or other vegetation, or of its fauna or natural or scientific features, or for any other similar cause" (Reserves Act, s 24).

Revocation of reserve status under the Reserves Act appears to be reasonably common. A search for revocation notices in the Gazette found 135 such changes between January 2017 and September 2022. Fifty-seven of those (for 22 hectares of land) were in Tier 1 cities. Around a third of those transactions involve land that had been gazetted for use as a public park. The remaining two thirds had been gazetted for a range of uses, including local purpose (road) reserves, local purpose (plantation) reserves and local purpose (utility) reserves.

A significant number of additional revocations are likely to take place in the near future as Auckland Council completes a 'reserve rationalisation' process that was initiated as part of its 2020/2021 Emergency Budget. As of late 2021, around 19 small urban parks and reserves – amounting to around 2.1 hectares in total – were being considered for disposal.[133]

The time required to revoke the reserve status of land is not insignificant, often extending well beyond a year. In addition, the outcome is not always certain.[134] That has led to the creation of several 'work-around' options in recent years.

The Urban Development Act 2020, for example, allows Kāinga Ora to request that the reserve status of a piece of land be revoked in order to allow a "specified development project" to go ahead. Under section 138 of the Act, the Minister of Conservation *must* give effect to such requests by "(a) applying in writing to the Registrar-General of Land to remove any registration or notation of the conservation interest from the record of title for the land; and (b) doing anything else necessary to revoke or cancel the conservation interest".[135] Land classified as a nature or scientific reserve (and some conservation land) is exempt from this provision.[136]

The other option available (once again) is to have recourse to Parliament. Box 3.8 highlights a recent example of where bespoke legislation has been used to circumvent protections provided by the Reserves Act.

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[133] Auckland Council, 2022f.

[134] In 2020, the then Minister for Conservation, Eugenie Sage, declined an application from Tauranga City Council to revoke the reserve status of 0.7 hectares of Marine Park Reserve (Rutherford and Motion, 2020).

[135] Urban Development Act 2020, s 138(4).

[136] Urban Development Act 2020, s 17(2).

**Box 3.8: The Point England Development Enabling Act**

Bespoke legislation has been used to override historical legal protections on urban parks and reserves. It has also been used to bypass the reserve revocation process set out in the Reserves Act.

The Point England Development Enabling Act 2017 – concerning 12 hectares of Crown-owned land with reserve status in central Auckland – is one example. This legislation originated in a proposal to transfer part of Point England Reserve to Ngāti Paoa. The reserve – a significant historical site for the hapū – represented part of the Ngāti Paoa Treaty settlement process.[137]

A proposal to allow Ngāti Paoa to develop the site was subsequently added, with the then Minister for Building and Housing, Hon Dr Nick Smith, stating that the purpose of the Bill was to "enable housing development … [in a] part of the city where housing need is at its most acute."[138] The originally proposed area for development was about 12 hectares; however, Ngāti Paoa agreed to a two-hectare development for a marae and papakāinga only, with the remaining area being retained as green space.[139]

Perhaps the most notable element of the Point England case was that the Government elected to revoke the reserve status of the land in question by introducing new legislation – rather than simply following the process set out in the Reserves Act. The regulatory impact statement that accompanied the Bill noted that the process offered by the Reserves Act was unlikely to be successful because of the public consultation requirement it contains. In particular, it was noted that Auckland Council had a 'no net loss of open space' policy in place for the Tāmaki area and was therefore unlikely to agree to the Point England development unless this was met.

Opting to revoke reserve status via an Act of Parliament is no small undertaking. The fact that it is even being considered suggests that provisions in the Reserves Act represent an effective safeguard against the widespread disposal of urban parks and reserves.

That raises the question of whether newly acquired public green space is being gazetted as a reserve in the first place. For a council looking to keep its future options open, holding land under the Local Government Act may be an attractive proposition. While community consultation is still required before disposal (see the section on protections for public green space under the Local Government Act below), the process is less prescriptive, and approval from the Minister of Conservation is not required.[140]

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[137] Auckland Council, 2017b, p.10; Ngāti Paoa, no date.

[138] New Zealand Parliament, 2016.

[139] Johnsen, 2020.

[140] There may be other advantages to holding public green space 'fee simple'. For example, it can simplify the process for allowing commercial activity (such as foodtrucks, events, or ongoing business leases) in public parks. Section 56(1) of the Reserves Act requires that any such activity be "necessary to enable the public to obtain the benefit and enjoyment of the reserve or for the convenience of persons using the reserve", a test which can apparently be difficult to meet.

Data on the proportion of newly acquired parks and reserves being given reserve status are non-existent. For the purposes of this report, a survey of Tier 1 councils was undertaken to better understand this. The resulting data indicate that most councils routinely gazette newly acquired open space as a reserve for the purposes of the Reserves Act. Auckland Council is the exception – only 50% of the land parcels acquired between 2016 and 2022 were given reserve status.

## Protections for public green space under the Local Government Act

Not all public parks and reserves benefit from legal protections under the Reserves Act. However, that does not mean that public green space without reserve status can be disposed of freely. Section 138 of the Local Government Act requires a local authority proposing to sell or otherwise dispose of a park, or part of a park, to first publicly consult on the proposal. Importantly, the definition of 'park' is broad – it includes "land acquired or used principally for community, recreational, environmental, cultural, or spiritual purposes".

While not as strong as those in the Reserves Act, this protection is likely to be significant in at least some situations. For example, Auckland Council has recently consulted on how the future of 13 public golf courses will be decided when existing leases expire. Around half of the leases in question expire before July 2027,[141] and at least three involve land in sought-after central locations (Chamberlain Park, Takapuna and Devonport). The land currently used for golf at Chamberlain Park and (part of that at) Devonport is not gazetted as a reserve for the purposes of the Reserves Act.

While golf courses are not sanctums of ecological purity, they still provide a range of biophysical and recreational services that buildings simply cannot. Given the area of land involved, any decision to develop Auckland's public golf courses would have a potentially significant impact on the availability of green space in the city.

## Vegetation protections under the Resource Management Act

### Protections for significant natural or ecological areas

Section 6 of the RMA requires local authorities to "recognise and provide for" various matters of national importance. In the context of urban open space, the most important of these is "the protection of areas of significant indigenous vegetation and significant habitats of indigenous fauna".[142]

Some local authorities have implemented this requirement by incorporating Significant Natural Area (SNA) or Significant Ecological Area (SEA) overlays into their district plans. In Porirua, for example, the SNA overlay covers around 17% of the council's administrative area.[143]

Controls on earthworks and vegetation clearance in SNAs and SEAs are stronger than elsewhere. That said, development is still possible. In Auckland, vegetation clearance that allows for a building platform and access way to be created is a controlled activity. Auckland Council retains control over the location of the building platform and accessway, the area of vegetation to be cleared (not more than 300 square metres per dwelling) and any measures to remedy or mitigate adverse effects. Similar provisions exist in Porirua, although only for vacant allotments that existed as at 28 August 2020.

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[141] Auckland Council, 2022e, p.23.

[142] RMA 1991, s 6(c).

[143] Porirua City Council, pers. comm., 23 November 2022.

Not all councils have incorporated SNAs or SEAs into their district plans. In several instances, proposals to do so have been withdrawn in response to public concern about regulatory overreach and impacts on private land values. In Lower Hutt, for example, proposed Plan Change 46 would have given SNA status to a large number of indigenous vegetation remnants, including those on around 1,200 privately owned properties. The plan change was withdrawn in 2018, with Hutt City Council agreeing to focus protections on council land, and to proceed on a voluntary basis on private land.[144]

Concerns about the limited and inconsistent application of indigenous vegetation protections across councils have led to calls for additional national direction from central government. The draft National Policy Statement for Indigenous Biodiversity (NPS-IB) – first published in 2019 and updated in 2022 – is a response to this.

If gazetted,[145] the NPS-IB will have implications for the protection of indigenous vegetation in urban (and rural) areas. Most importantly, it will strengthen and clarify existing requirements on territorial authorities to identify areas of significant indigenous vegetation (or significant habitat for indigenous fauna) as SNAs. The process for doing so will be standardised using direction set out in the NPS-IB.[146]

Ultimately, territorial authorities will need to incorporate SNAs – and policies and methods for their management – into district plans. Based on the contents of the exposure draft of the NPS-IB published in mid-2022, subdivision or development in SNAs would generally be required to *avoid* any loss of ecosystem representation or extent, any disruption to ecosystem function, or any fragmentation or loss of connectivity. While that is clearly a high bar, the draft NPS-IB contains a long list of often material exceptions. These include for specific types of infrastructure,[147] mineral or aggregate extraction, and the construction of a single residential dwelling, so long as there is a functional or operational need for the infrastructure or development to be in that particular location.

In the context of urban green space, the other notable aspect of the NPS-IB is the inclusion of a target for indigenous biodiversity coverage. Under section 3.22, every regional council must assess the proportion of indigenous vegetation cover in each of the urban environments under its jurisdiction, and set a target of at least 10% in situations where actual coverage falls below that. District and city councils, in turn, "must promote the increase of indigenous vegetation cover" having regard to (among other things) these targets.

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[144] Stuff, 2018; Wainuiomata Rural Community Association Inc, 2021.

[145] According to the Ministry for the Environment (2022b), the intention is that national direction developed under the RMA system (such as the NPS-IB) will be translated into the new national planning framework.

[146] The NPS-IB sets out four criteria for the identification of SNAs: representativeness; diversity and pattern; rarity and distinctiveness; and ecological context (Ministry for the Environment, 2022a). Areas meeting at least one of these criteria qualifies as an SNA.

[147] Which includes, among other things, electricity, three waters, telecommunications and transport networks (Ministry for the Environment, 2022a, p.10).

## Tree protections

Section 76 of the RMA allows territorial authorities to create rules that "prohibit or restrict the felling, trimming, damaging, or removal of a tree or trees" on private land.[148]

Critically though, such protections require the tree or trees in question to be specifically identified in the relevant district plan. That requires councils to undertake a plan change process every time a protection is considered worthy. This is neither fast nor cheap. Nominated trees need to be individually assessed to establish their worthiness for protection. A plan change and associated section 32 evaluation report also need to be prepared, and public submissions heard.

The barrier this process poses for the protection of notable trees has been well canvassed in Auckland. Between 2016 and 2021, Auckland Council failed to process any of the 587 nominations it received for tree protections[149] – something that has been the subject of a recent judicial review.[150] The cost of scheduling trees was a major factor in Auckland Council's decision not to process nominations – it was estimated that adding a tree to the Notable Tree Schedule costs $1,484 and takes between 34 and 42 months.[151] As Phil Goff, the then Mayor of Auckland, said in February 2022:

> "the removal of these [blanket] protections means councils must rely on listing individual trees at significant cost, and this has resulted in a lack of protection for large numbers of trees of notable size and character across Auckland. Although we are able to schedule specifically identified notable trees, doing so tree by tree is costly and time-consuming, and will only protect a small minority of Auckland's important trees".[152]

As of June 2022, Auckland's Unitary Plan contained 6,000–7,000 scheduled trees. The number is much lower in other cities. In Hamilton, Tauranga, Upper Hutt, Lower Hutt, Porirua and Wellington City, fewer than 500 trees had been scheduled.[153] In other words, the vast majority of trees in our larger cities enjoy no legal protection and can be removed at any time at the discretion of the landowner.

Councils have not always had to rely on scheduling individual trees in order to protect them (Box 3.9). Prior to 2009, the RMA allowed councils to use general (or blanket) rules to protect trees in particular places, of particular species, or above certain heights.[154] Removing or trimming protected trees was an activity that required resource consent. That meant that around 10% of all resource consent applications – around 5,000 in 2009 – were for tree removal.[155]

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[148] RMA 1991, s 76(4A).

[149] Auckland Council, 2020, p.53.

[150] Tree Council, 2022.

[151] Auckland Council, 2020, p.52.

[152] Maryon, 2022.

[153] PCE analysis.

[154] Under the rules of the legacy Auckland City Council, for example, native trees over 6 m in height or 600 mm in girth and exotic trees over 8 m in height or 800 mm in girth were protected (Ikin, 2005).

[155] New Zealand Parliament, 2009.

**Box 3.9: The evolution of tree protection rules under the RMA**

Tree protection laws have undergone two significant reforms during the last decade. In both cases, the objective was to reduce the administrative burden for landowners seeking to trim or remove trees.

As noted above, the Resource Management (Simplifying and Streamlining) Amendment Bill 2009 required trees – or groups of trees – to be "specifically identified" in a district plan to be protected. In effect, that shifted the presumption from 'urban trees are protected unless council has granted resource consent' to 'landowners can fell or trim any tree or trees so long as it has not been identified by council'. As the then Minister for the Environment, Hon Dr Nick Smith, said at the time, "the bill also tackles the arcane bureaucracy of blanket tree protection rules whereby people have to apply for a resource consent to do none other than trim their own tree".[156]

Further amendments were made to the RMA in 2013. These clarified what 'identified' in the district plan meant in practice: that the tree or trees had to be described and the allotment on which they were on specifically identified by street address. This put an end to local authorities using maps alone to identify protected trees.

For councils, these changes have reduced the resources needed to process resource consent applications. At the same time, they have meant that considerably more time and effort is required to protect urban trees. As the then leader of the Green Party, Jeanette Fitzsimons, presciently noted during the third reading of the 2009 Bill, "instead, he [the Minister] proposes to saddle councils with the time and cost of describing every tree that is worth protecting and scheduling them, and dealing with every submission that opposes scheduling a tree. That will be enormously more trouble than processing consents. Most councils will not do it or will leave out very significant trees that the community values."[157]

If the old system for protecting urban trees failed to respect the right of landowners to determine what takes place on their land, the current system fails to acknowledge that some of the services provided by trees extend beyond property boundaries. A better balance is required.

Recent comments by the Hon Phil Twyford, Associate Minister for the Environment, provide some cause for optimism. The Minister has recently emphasised the value of urban trees, noting that "they bring beauty to our lives, they attract birds, they give shade, [and] they are good for our mental health".[158] He has proposed that it should be made easier for councils to make rules for trees of a certain size or age. This reflects the fact that large mature trees – both native and exotic – can offer environmental services that extend well beyond those captured by private landowners.

[156] New Zealand Parliament, 2009.
[157] New Zealand Parliament, 2009.
[158] New Zealand Parliament, 2022.

The Minister has also highlighted that regulation is not the only means of protecting urban trees, and that councils could make greater use of financial incentives to *encourage* tree protection. The mechanism proposed – rebates on financial contributions – certainly offers one way forward. But other options also exist. For example, consideration could be given to offering rates remissions in exchange for legal covenants over significant trees or vegetation. This is provided for under section 102 of the Local Government Act 2002 and is currently used by a number of councils to encourage the protection of historic, cultural or natural heritage. Kaikōura District Council, for example, offers a rates remission of 50% on land with a Queen Elizabeth the Second National Trust covenant over it.

There is clearly a live debate here. Neither the current approach nor the previous blanket approach have proved satisfactory. More work is needed to find a middle ground that reconciles private rights and the public good provided by the trees.

# 4

*Asplenium obtusatum*

# The future of urban green space

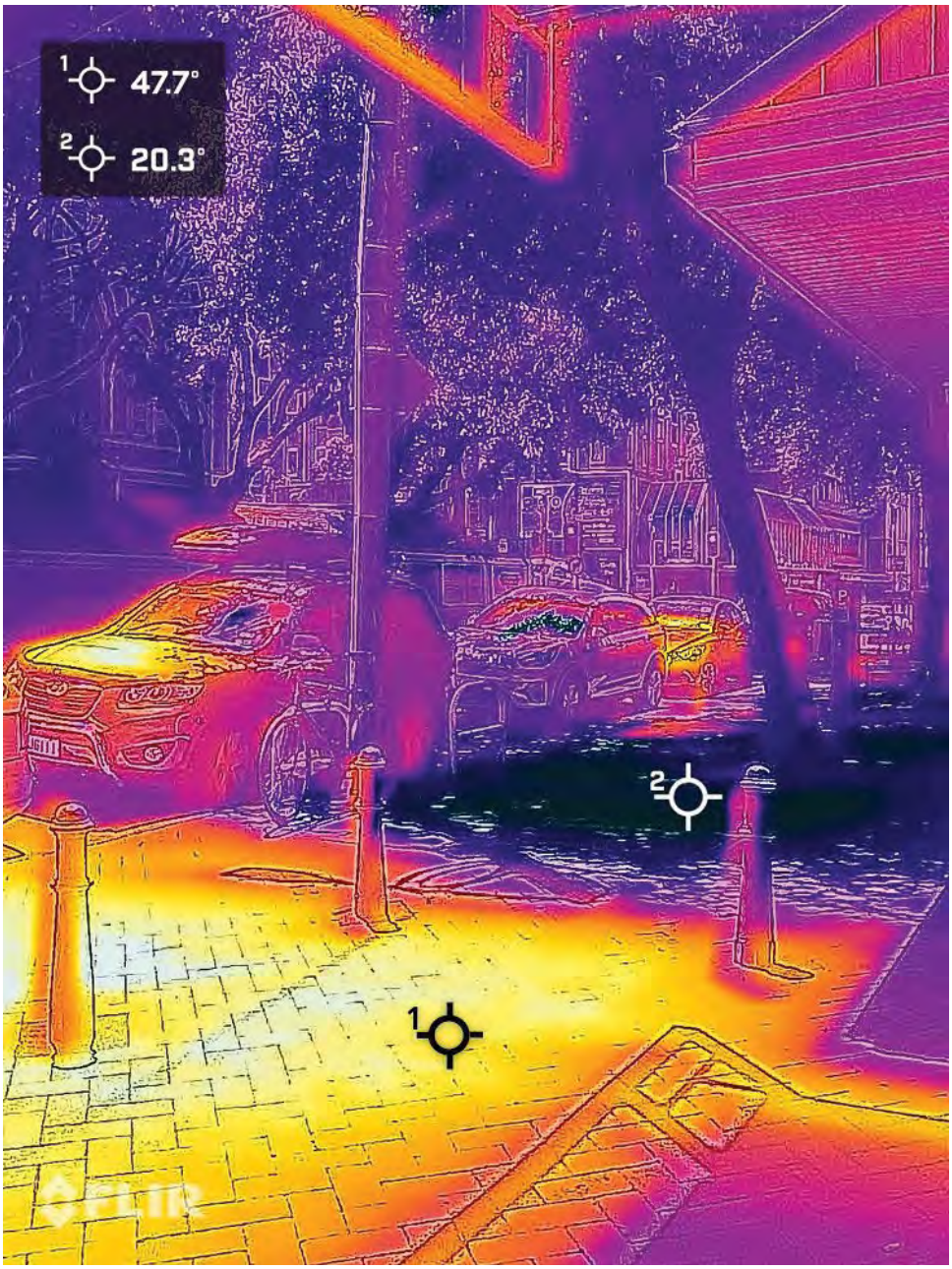
This report has detailed the way urban development patterns and policies have shaped urban green space in New Zealand cities over the past 80 years. What will the future hold?

New Zealand's larger cities look set to grow in population for some time. Accommodating that growth will inevitably lead to changes in the shape and texture of the urban landscape. That is to be expected. Change can be an important part of what makes cities such vibrant human ecosystems. But urban growth and development also come with risks – a continuation of the largely irreversible loss of green space being a prominent one.

As our cities grow, they will also increasingly feel the effects of climate change. That will mean increased heat and more frequent extreme rainfall events. Parks, yards, vegetated berms and trees can help to mitigate the impacts of both, but only to the extent that they remain healthy and functioning in what is likely to be a more challenging environment.

Climate change will make the environmental services provided by green space more important in future. At the same time, the ongoing shift towards townhouse and apartment living – and associated reduction in the size of sections and yards – will make the recreational offering provided by public parks and reserves more sought after. The reality is that, at the very time that urban green space is likely to be in greater demand, there is likely to be less of it available.

Any future-gazing involves a degree of uncertainty. But based on modelling of climate, population growth and the impacts of current policies, we can develop a plausible understanding of how our cities may look in 20 years' time.




Source: Dr Ashley Broadbent, NIWA

**Figure 4.1: The differences that green spaces make can be dramatic. This image, captured with an infrared camera, reveals the surface (not air) temperature on a sunny summer afternoon on a treelined street in central Wellington. The image was taken at 2:10 pm on 18 January 2023 at the corner of Willis and Dixon streets, when the air temperature was 23 °C. The yellow areas are hotter surfaces, and the blue/black areas are cooler. The surface temperatures at two locations are shown at the top left of the image. The pavement in full sun is 47.7 °C, more than twice the air temperature, whereas the ground under the tree is 20.3 °C, which is actually cooler than the air temperature.**

## Population pressure

The population of urban New Zealand is forecast to grow considerably in the coming decades. Stats NZ projects the populations of Auckland, Hamilton, and Tauranga to all grow by more than a third by 2043 (i.e. by 553,000, 57,900 and 49,300 people, respectively). Christchurch and Greater Wellington are also expected to grow over the same period, but more slowly (70,000 and 65,700 people, respectively).[1]

Household occupancy rates are also projected to decline slightly or remain static. For Auckland, this means the average number of people per household is expected to decline from 3.0 in 2018 to 2.9 by 2043, and for Hamilton a decline from 2.8 to 2.7.[2] While this is a proportionally small effect, having fewer people per household implies an increasing number of dwellings would be required to house even a static population.

The combined effect means that by 2043 an extra 208,100 households are expected to be needed in Auckland, 22,000 in Hamilton and 20,700 in Tauranga. This equates to around a 37% increase for all three cities from 2018 levels. Again, growth is expected to be more subdued in Christchurch and Greater Wellington. Christchurch can expect 28,400 more households by 2043 (around a 19% increase). A similar 20% increase is also expected in Wellington City and the Hutt Valley, while Porirua City can expect something approaching 25%.

## How will the built form change in response to population pressure?

Many of New Zealand's Tier 1 councils have outlined how they are intending to accommodate expected population growth in their spatial strategy documents (Table 4.1).

[1] Stats NZ, 2021c. Based on medium scenario projections from 2018 base year. For additional information regarding the methods used to derive these estimates, see https://www.stats.govt.nz/methods/population-statistics-user-guide.

[2] Stats NZ, 2021a. All household projections presented are based on the medium projection scenario, which is regarded by Stats NZ as the most appropriate scenario for assessing changes in household numbers and composition. For additional information regarding the method used to derive these projections and accompanying caveats and limitations, see https://www.stats.govt.nz/methods/2018-base-family-and-household-projections-data-and-methods/.

**Table 4.1: Summary of intended accommodation of future development for selected cities.**

| City | Target and associated development type |
|---|---|
| **Tauranga** | 30–40% of population growth accommodated through infill or intensification[3] |
| **Auckland** | 60% of expected growth in dwellings accommodated through intensification[4] |
| **Hamilton** | At least 50% of growth in dwellings accommodated through intensification[5] |
| **Wellington City** | 90–95% of expected growth in dwellings accommodated through intensification[6] |
| **Greater Christchurch** | 45% of projected housing growth across the greater Christchurch area (including parts of Selwyn and Waimakariri district councils) accommodated through the redevelopment of existing urban areas in Christchurch City[7] |

Recent central government direction will tilt the balance further towards intensification in New Zealand cities. Modelling of the impact of the National Policy Statement on Urban Development (NPS-UD) and Medium Density Residential Standards (MDRS) provide an indication of the number of additional dwellings that might result from each of these policies.[8] Figure 4.2 shows the forecast long-term impact of both policies across five main urban centres.[9]

In Auckland, the introduction of the NPS-UD was estimated to result in around 50,000 additional dwellings relative to a business-as-usual scenario. Modelling for Hamilton and Tauranga projected an increase of 4,000 and 6,000 additional dwellings, respectively, that could be attributed to the NPS-UD. In contrast, the impact of the NPS-UD in Wellington City was relatively modest, with an increase of about 2,000 dwellings modelled.

With respect to the intensification provisions contained in the MDRS, the modelled impact showed a larger increase in dwellings, something which reflects the geographically broader scope of the policy. In Auckland, the introduction of the MDRS is modelled to result in an additional 112,000 dwellings. In Christchurch, the MDRS are expected to increase dwelling numbers by about 33,000 over the long term.

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[3] SmartGrowth, 2021a, p.74; SmartGrowth, 2021b, p.55.

[4] Auckland Council, 2018, p.217.

[5] Future Proof, 2022a, p.7. The *Draft Hamilton Urban Growth Strategy* seeks to accommodate 70% of long-term growth through intensification (Hamilton City Council, 2022b).

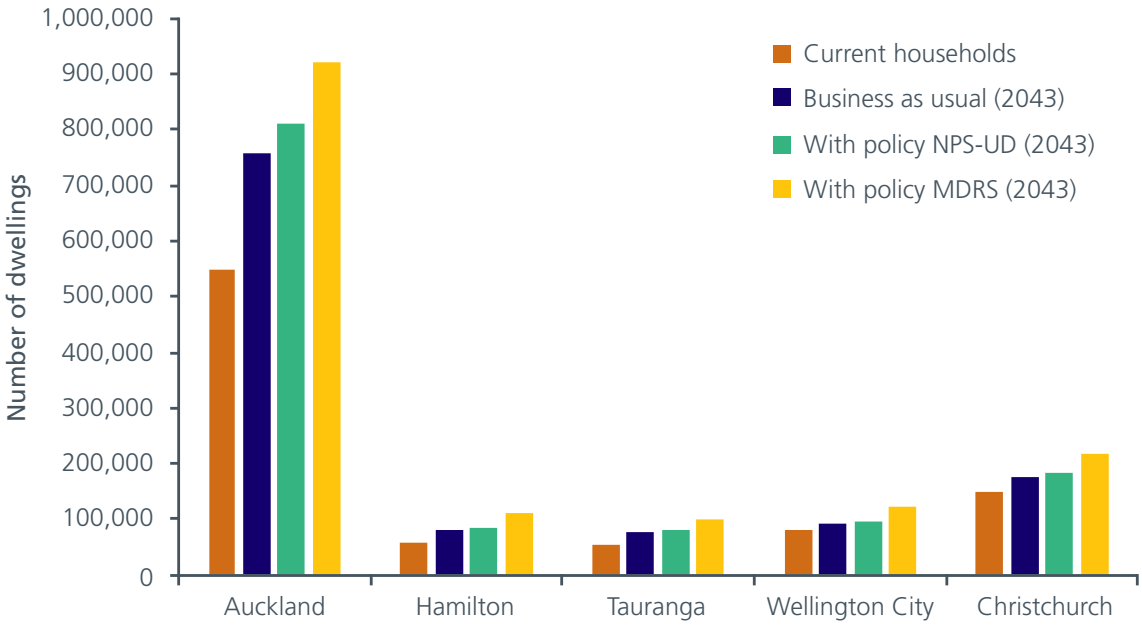
[6] Wellington City Council, 2021b, p.9. Across the wider Wellington-Horowhenua area, approximately two-thirds of housing growth over the next 30 years is expected to be accommodated in existing urban areas through infill and intensification (Wellington Regional Growth Framework, 2021).

[7] Greater Christchurch Partnership, 2019.

[8] Modelled analysis is derived from cost–benefit analysis commissioned by the Ministry for the Environment to assess the respective impact of each of the intensification policies. The impact of each policy was assessed against a counterfactual scenario that assumed the absence of the policy intervention. For additional details regarding the method and assumptions employed, refer to the respective documents produced by PwC and Sense Partners (2022) and PwC (2020).

[9] The estimates presented in Figure 4.2 are compiled from several different sources. The figures relating to the current number of households are derived from statistics produced by Stats NZ. Additional households associated with the business-as-usual scenario and the NPS-UD scenario are derived from an analysis undertaken by PwC (2020). Additional households associated with the MDRS scenario are sourced from a cost–benefit analysis undertaken by PwC and Sense Partners (2022).

Relative to the current number of households, business-as-usual development trends together with the NPS-UD and MDRS are forecast to increase the number of dwellings in Auckland by about 68% and by about 46% in Christchurch. In Wellington City, the impact of both policies is expected to result in a 56% increase in the number of dwellings. The percentage increases in other urban centres are larger. In Hamilton and Tauranga, the modelled impact of both intensification policies is expected to increase the number of dwellings by 85% and 80%, respectively.




Source: Stats NZ, PwC (2020), Sense Partners (2022)

**Figure 4.2: Modelled impact of the NPS-UD and MDRS on new dwelling construction, 2018–2043.**

## How might changes to the built form affect private green space?

A footprint analysis was undertaken to give a sense of the amount of green space in existing suburbs that might be built on or sealed over as a result of future urban development. This involved converting forecasts of residential dwellings growth into equivalent land areas based on assumptions about the location (urban vs peri-urban) and footprint (area of dwelling plus associated sealed areas) of different build types.

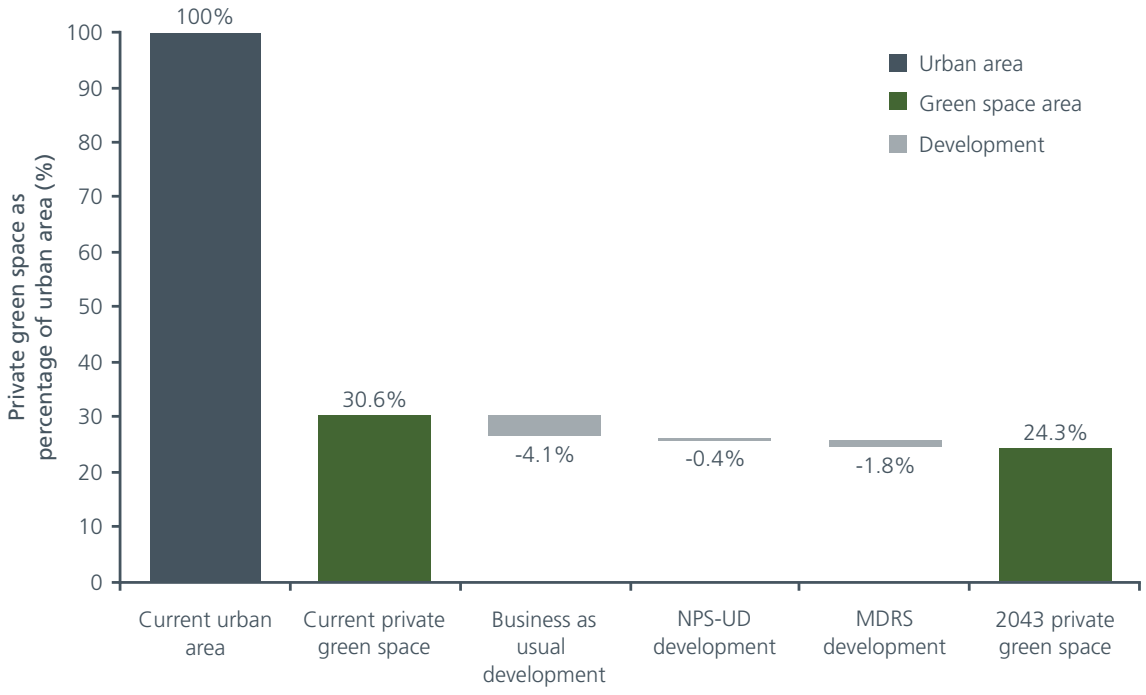
Three forecasts of future dwellings growth were combined to create a scenario for urban development to 2043. Stats NZ's Family and Household Projections were used as a business-as-usual baseline. For this forecast, the location and type of developments (standalone, townhouse, apartment) were based on current market outcomes (see chapter two). This business-as-usual future was supplemented by forecasts of the likely impacts of the NPS-UD (by PricewaterhouseCoopers (PwC)) and MDRS (by PwC and Sense Partners). It was assumed that all new dwellings associated with these policies will be built within the urban area as it exists today.

Forecast dwellings growth was classified into three discrete typologies: standalone houses, two-storey townhouses, and six-storey apartment buildings. Representative footprints of each were taken from recently built analogues in Auckland. The suburb of Karaka was used for standalone

houses (250 square metres), Hobsonville Point for two-storey townhouses (85 square metres), and the recent Set Apartments in Avondale for six-storey apartment buildings (42 square metres).

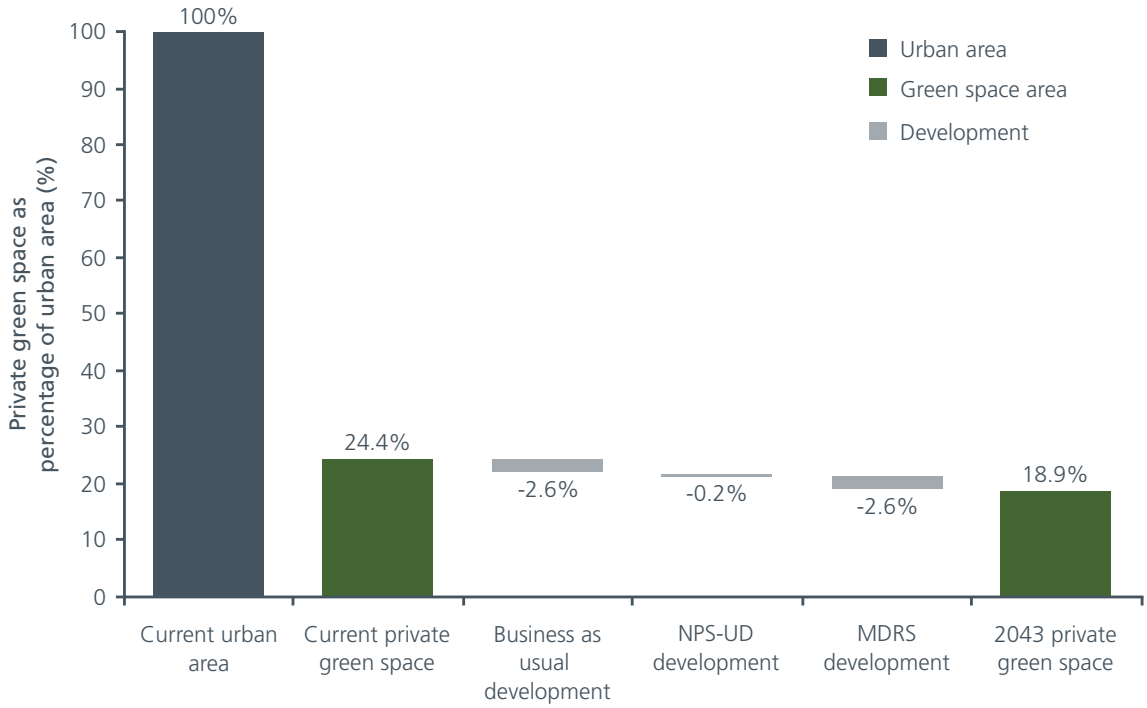
The analysis suggests that forecast residential development will make significant claims on private green space in existing urban areas (Figures 4.3 and 4.4). In Auckland, the footprint of the additional 370,000 dwellings expected to be built by 2043 equates to roughly 3,300 hectares – around 20% of the existing area of private green space. In Hamilton, the footprint of the 50,000 dwellings expected to be built amounts to around 400 hectares. Again, this is around 20% of the existing area of private green space.

Not all of this development will take place in private yards and gardens. Some of it will involve the demolition of existing buildings and site redevelopment, with less impact on pre-existing green space as a result. In that sense, the results shown in Figures 4.3 and 4.4 probably represent a maximum estimate of the impact that future development will have for private urban green space. It is also worth keeping in mind that these results are city-wide averages. In reality, the rate of infill and upwards development will differ across the city as a consequence of zoning rules as well as market dynamics. It is likely that the reduction of pre-existing green space will be more extensive in some suburbs than others.




Source: PCE analysis

**Figure 4.3: Potential impact of forecast future development on private green space in existing urban areas in Auckland.**




Source: PCE analysis

**Figure 4.4: Potential impact of forecast future development on existing intra-urban private green space in Hamilton.**

## Could the provision of new public green space help to counteract a reduction of private yards and gardens?

Future losses of intra-urban green space resulting from intensification could, in theory at least, be partially offset by the creation of new public green space. However, as discussed in chapter three, councils are already struggling to acquire the land required to retrofit new parks and reserves into existing neighbourhoods. That task will only become more difficult as land prices increase in response to up-zoning and intensification.

## What a changing climate means for urban green space

Any further reduction in the amount of green space in our cities will likely result in the loss of ecosystem services like cooling, stormwater regulation and habitat provision. At the same time, the ability of green space to provide these services may well be compromised by climate change.

### What will climate change mean for New Zealand cities?

The climate is changing the world over. The incidence of these changes in any particular location varies significantly depending on a range of factors such as region and season.[10]

While not every region of the world is warming at the same rate,[11] one global consensus is that surface temperature extremes are closely correlated with surface temperature changes.[12] This means that in places where it is much warmer on average, many more heat extremes can be expected (and also many fewer cold extremes). This pattern is important because extreme climate events can be particularly damaging and also because an overall global warming trend is set to continue far into the future regardless of how stringent future global mitigation actions are.[13]

Temperature records show that considerable changes have already occurred. According to the National Institute of Water and Atmospheric Research (NIWA), New Zealand's average annual temperature increased by 1 °C over the last 100 years.[14] Looking forward, a regional climate model developed by NIWA found that, despite some regional variation, overall average temperatures will continue to increase throughout the country this century – as will the number of extreme hot days.[15,16]

Assuming the world follows the most ambitious emissions reduction pathway, New Zealand can expect a further increase from today of 0.7 °C in average temperature by 2040. An additional three or more degrees Celsius of warming from today can be expected by 2090 if emissions follow the high emissions pathway that the Intergovernmental Panel on Climate Change considers.[17]

While the full extent of warming may be unclear, the future will definitely bring more hot days and nights to New Zealand cites, and more heat extremes too.

The impact of climate change on the water cycle is more complex and nuanced. Precipitation patterns are changing as the planet continues to warm. Some parts of the world are getting wetter, others drier.[18] NIWA's regional climate model again provides some local context. It predicts that there will be regional and seasonal variation in precipitation around New Zealand – with a general pattern of increased rainfall in the south and west, and drying patterns in the north and east. Therefore, our larger cities (predominantly in the east and north of the country) may experience a decrease in future rainfall, especially during winter.

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[10] Masson-Delmotte et al., 2021, p.1608.

[11] For example, the poles are reported to be heating up to four times faster than the global average (Harvey, 2022).

[12] Seneviratne et al., 2012, p.112.

[13] The extent to which ongoing changes will continue in the future remains highly uncertain – as some future changes are dependent on future efforts to rein in global emissions. Nevertheless, further change is guaranteed – a hangover from past emissions alone.

[14] NIWA, no date.

[15] Ministry for the Environment, 2018.

[16] NIWA, 2022. New, regional climate change projections for New Zealand based on the latest IPCC AR6 are also currently underway (Bodeker et al., 2022).

[17] NIWA, 2022.

[18] Masson-Delmotte et al., 2021, p.1608.

But that is just the average rainfall. Extreme rainfall events are expected to increase in frequency all around the country. More intense rain events are already occurring more often in New Zealand because of climate change, placing strain on existing stormwater infrastructure.[19] For example, the floods in Canterbury in May/June 2021 that caused $44 million in insured losses have been estimated to have been 20% more likely and 10–15% more intense due to anthropogenic climate change.[20] There will also be a climate signal in the massive Nelson floods of August 2022.[21]

Even more intense rain events can be expected. Much of this can be put down to the fact that a warmer atmosphere can hold more water. For each degree of regional warming in New Zealand, extreme precipitation is expected to increase by between 5 and 12%.[22] Councils are already requiring that developers factor in increased flows due to climate change when calculating stormwater requirements for new developments. NIWA has developed an online tool that helps them do this.[23]

At the other extreme, more dry days can be expected in the North Island and inland South Island.[24] Droughts will be more common.

Overall, in terms of water, extremes of one kind or the other – floods or severe droughts (with increased fire risks) – can be expected in most areas of the country in future.[25]

## How will the ability of green spaces to provide benefits be impaired by climate change?

Climate change poses many ongoing challenges for the health and function of urban green spaces themselves. The biophysical benefits of urban green spaces are either directly or indirectly due to the living ecosystems within them. It is the plants, animals and microbes that drive these valued processes, so their health is paramount.[26]

Some of the impacts of climate change may be beneficial to parts of ecosystems. For example, the warmer and wetter climate that is expected in the south and west of the country could be more conducive to plant growth.

But since these average changes are likely to be accompanied by more extreme events, overall green spaces are likely to suffer more as the climate warms. More intense floods, droughts and strong winds can all be expected to cause considerable harm to the ecosystems in urban green spaces. That may well be exacerbated by the apparent inadequacy of the soil in which many shrubs and trees seem to have been planted in recent years. In addition, since most New Zealand cities are located on the coast, ongoing sea level rise will erode and flood some existing riparian green spaces.

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[19] Galuszka, 2022.

[20] Naish, 2021. See also Te Uru Kahika – Regional and Unitary Councils Aotearoa, 2022, pp.28–29.

[21] Climate attribution modelling is a developing field in New Zealand (Frame et al., 2020; Tradowsky et al., 2022) and overseas (see https://www.worldweatherattribution.org/).

[22] Carey-Smith et al., 2010.

[23] See https://hirds.niwa.co.nz/.

[24] Changes such as altered wind patterns, radiation and humidity can be expected (NIWA, 2022).

[25] Bodeker et al., 2022.

[26] All living things have an optimal set of basic conditions within which they can survive and function. While individual species may differ markedly in what they need, any species living outside of their safe zone will struggle and, when pushed too far, will die.

Drought-stressed plants will not provide as much cooling or shade benefit if they are wilted, and next to none if they die.[27] Flooded soils cannot provide additional water retention if they are already saturated. Conversely, drought-stressed lawns restrict percolation of water through the soil so that when rain does arrive, less water is soaked up and more flows over the surface, accelerating flooding. High winds snap and uproot plants and damage foliage.

Climate change will add to the considerable pressures urban wildlife already face. If ecosystems are stressed, then various species of plants and animals in them may not cope and biodiversity will likely suffer. The mauri of a place will suffer and the connection between people and the environment along with it.

## Twenty years from now, what will our cities be like?

While the general trends suggest that the benefits provided by urban green spaces will be eroding in the future, this section outlines what city life may be like in a typical Auckland suburb 20 years from now.

Today, around 30% of Auckland's urban area is private green space. Expected population growth and intensification have the potential to reduce this area by 5–10 percentage points over the next 20 years or so (Figure 4.3). This equates to losing around 3,000 hectares of Auckland's existing private green space.

If current trends continue, existing parks and reserves are likely to remain relatively untouched by future development. Instead, continued intensification will see more lawns and private gardens replaced by new dwellings, and much of the remaining green spaces covered with impermeable surfaces for vehicle access and parking. Street trees may or may not survive. This will depend on if they are in the way of development, if they are protected or not, and if councils continue to maintain them in a healthy state.

Overall, there will be fewer large trees or diverse patches of bush in private gardens. The suburbs will feel hotter and harder, and there will be more artificial noise (from the activities of more people) and less birdsong (as biodiversity declines).

It may be tempting to think such losses on primarily private land are purely the concern of individual landowners. They are not. A large tree in the front garden of an existing section will provide shade and cooling benefits to pedestrians and nearby houses, and help regulate stormwater flows originating from the section. At the same time, the tree will support biodiversity while also filtering noise and particulate pollution.

### How much hotter could it really be?

Twenty years from now a typical Auckland suburb will likely be between 0.5 and 1.0 °C warmer on average due to climate change alone.[28] But what will a leafy suburb feel like compared to a less leafy one? Quantifying the effect of adding or subtracting urban green space on urban temperature is not easy, and there is little domestic research that can inform this calculation. Nevertheless, it is possible to use overseas experience to glean some indication of the sort of impact that can be expected.

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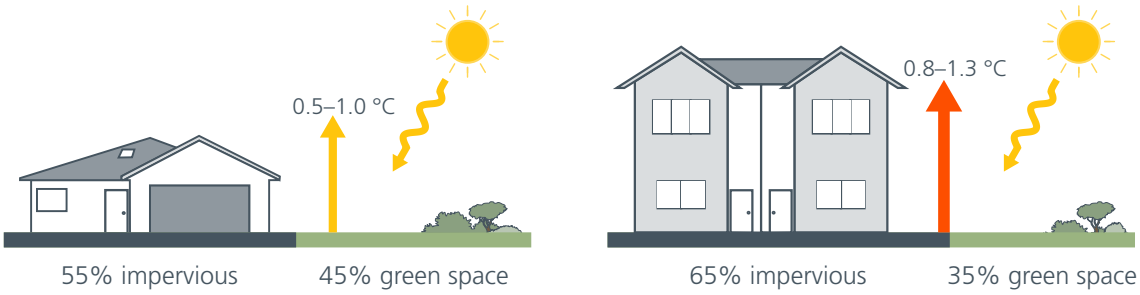
[27] Increasing the risk of fires too.

[28] Under the RCP4.5 Scenario, summer and autumn are expected to warm more than winter and spring (Pearce et al., 2020).

A recent global review of urban heat modelling set out to estimate the contributions of various factors, including green space.[29] This meta-analysis estimated that a 10% increase in green space reduced neighbourhood average air temperatures by 0.3 °C. Hence, the magnitude of the temperature change due to green space gains or losses could be as much as half that predicted for Auckland by climate change over the next 20 years (Figure 4.5). This back-of-the-envelope calculation suggests that the expected loss of urban green space will be noticeable in terms of urban heat in Auckland in coming decades.

Moreover, the impacts of trees are likely to be even larger when the localised cooling impacts of shading are considered (see Figure 4.1).




Source: Pearce et al. (2020) and Krayenhoff et al. (2021)

**Figure 4.5: The estimated increase in average air temperatures in an Auckland suburb 20 years from now due to climate change will be compounded by further loss of green space as intensification occurs. Research suggests that a 10% loss of green space could add a further 0.3 °C of warming.**

In the longer term, different local climate predictions diverge considerably as to how much further warming will occur. The bleakest projections estimate that Auckland suburbs will be over 2 °C warmer by the end of the century.[30] It remains to be seen how much green spaces will help then.

## Where will all the water go?

Climate change will mean the pattern of rainfall received by a typical Auckland suburb will be quite different 20 years from now. Increased atmospheric heat will mean that extreme rainfall events will occur with increasing frequency and intensity.[31]

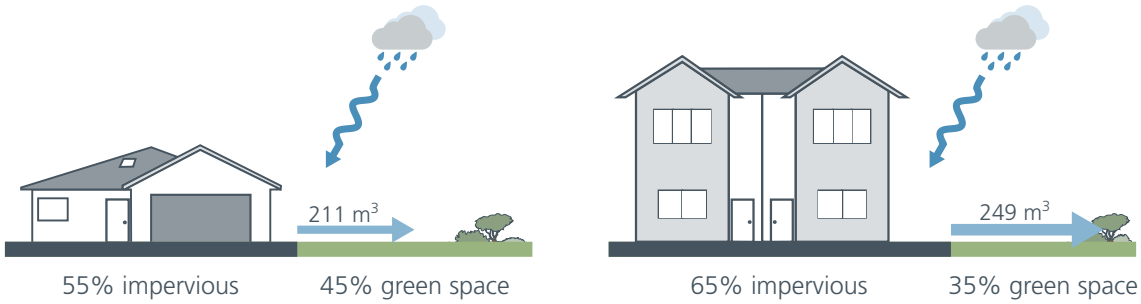
An increase in impermeable surfaces will considerably change how this water moves through the city. Remaining green spaces will help to regulate rain events to some degree, but their capacity to buffer extreme events will be more limited.

[29] Krayenhoff et al., 2021.

[30] Regardless of how severe future climate change turns out to be, regional climate models predict very little change in Auckland's average annual precipitation between now and the end of the century (Pearce et al., 2020).

[31] NIWA's regionally downscaled climate modelling also predicts changes in precipitation over the rest of this century for various parts of New Zealand.

Sophisticated stormwater models are available and are used to design larger new developments. But even basic models – like Auckland's online stormwater device sizing tool – can give some idea of what is to come as the city fills in and covers up.[32] Using the tool, stormwater flows for an area roughly the size of a city block in Auckland that currently has 55% impervious area and 45% green space were compared with expected flows from the same area if the green space was reduced to 35% (Figure 4.6). For a rainfall event that delivers 24 millimetres of rain in 24 hours, this reduction in green space will mean that an extra 38 cubic metres of rainwater will need to be managed. This represents an 18% increase in volume that needs to go somewhere – from just one rainfall event.



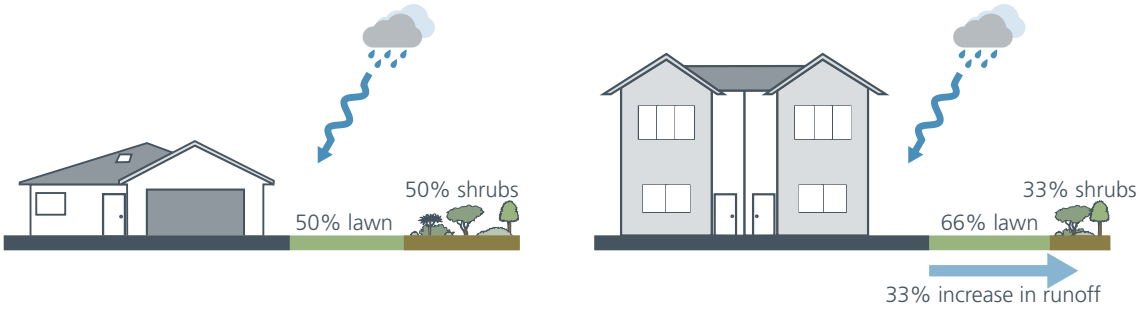

Source: Stormwater Device Sizing Tool, Auckland Council

**Figure 4.6: A basic indication of the impact of green space loss on stormwater runoff from a single rainfall event of 24 millimetres of rain over 24 hours. Regardless of the actual value, large increases in runoff can be expected as the ground is sealed over.**

Another (United States-based) online calculator estimates that the same increase in impervious surface area described above would lead to a 25% increase in annual stormwater runoff in a city with similar annual rainfall to Auckland (Portland, Oregon).[33] This more sophisticated tool also allows the impact of changing the type of green space to be examined. If the ratio of green spaces covered in lawn versus spaces covered in larger shrubs and trees were also to change from the current 50/50 split to one where lawns accounted for two thirds of the remaining green spaces, then the annual runoff would be 33% higher than it is now (Figure 4.7).

[32] See https://tools.aucklandcouncil.govt.nz/storm-water-device-sizing-tool/#/.

[33] See https://greenvalues.cnt.org/index.php.




Source: Green Values® Stormwater Management Calculator, Center for Neighborhood Technology

**Figure 4.7: Both losing green space and changing its composition will impact stormwater runoff. This figure shows the kind of impact of changing composition (from as it roughly is today, 50% lawns, 50% shrubs, to a world with more lawns and less shrubs) assuming an overall loss of green space too (10% of total area). While the values are only indicative, the message is clear: lawns create more runoff to deal with.**

The future Auckland suburb will also likely produce much higher peak flows into its receiving environment because water will move faster over the increased proportion of impermeable surfaces. With fewer green spaces available to filter the water and air, more pollution can be expected to be deposited in these environments too.

It remains unclear what condition many remaining green spaces will be in in 20 years' time. However, the combined impact of climate change and increased fragmentation does not bode well for their structure or function, with biodiversity being one likely loser.

In summary, intensification and climate change will mean that a typical Auckland suburb will be hotter and more prone to flooding in future. Neither of those problems is intractable. They can be solved by existing engineering options: air conditioning is increasingly being used around the world to offer respite during hot periods, and the capacity of traditional stormwater infrastructure can be upgraded to mitigate flooding risk. These engineered solutions come with costs. But more importantly, they provide none of the biodiversity, recreational and cultural co-benefits that make green space such an important element of a healthy, liveable city.

Before building or sealing over more, it would be worth considering whether a future largely devoid of backyard nature is really one we want to live in. Or, if that is to be the outcome of urban planning, whether significant new areas of public green space need to be created. This, like engineered solutions, will be costly – and difficult to achieve in inner-city areas.

## Securing the future we want

New Zealand's urban green spaces face two clear pressures moving forward – population growth and climate change.

Our urban centres are becoming denser. Packing more people into them will almost certainly increase the demand for green space for the recreational, wellbeing and environmental services they provide. But the way we are building more houses to accommodate a growing population places existing green space at risk and makes the provision of new green space more difficult within existing urban boundaries and more costly everywhere.

Our climate is changing. The environmental services urban green spaces provide will be more important in a warmer, more extreme world. Unfortunately, the ecosystems providing those services will be under increasing heat and water stress.

Even if our 'typical' Auckland suburb does not grow over the next 20 years, climate change means our green spaces will have to help mitigate between 0.5 and 1 °C of additional warming and have to deal with more weather extremes too. If ongoing intensification and infill development result in a continued loss of green space, then increasingly stressed ecosystems will be asked to do even more than they do now to help mitigate up to 1.3 °C of additional warming.

This outcome is not preordained. But the choices we make today about how we want to manage population growth, urban form and green spaces will be ones we live with forever. Recommendations on what we need to know to assist us in making those choices form the substance of the next chapter.


Source: Isthmus Group Ltd, Eke Panuku Development Auckland

**Figure 4.8: A design image for Te Ara Awataha, Northcote's new greenway. As individual yards and sections shrink, local public green space becomes increasingly important. Not just for biodiversity and people's health and wellbeing, but also for the biophysical services green space provides. As we grapple with a changing climate, how we create and preserve our urban green spaces will impact how we experience catastrophic weather events into the future.**

# 5

*Schizaea bifida*

# Recommendations

## Expanded consideration of urban green space in council planning processes

**Recommendation 1: Statutory planning documents adopted by regional councils and territorial authorities should include more explicit provisions on green spaces based on consultation with their communities.**

**These provisions should identify the key environmental, recreational and cultural services that green spaces provide, the extent to which these could be compromised by urban development, and the steps councils will take to avoid their loss taking into account the likely future effects of climate change.**

Green spaces are an important element of well-functioning, liveable urban environments. They need to be planned and resourced in the same way and with the same care that provision is made for housing, commercial and cultural spaces, and infrastructure.

Councils need to engage better with their communities about urban green spaces. They should be able to outline the current services that public and private green spaces provide and discuss the trade-offs that are at stake should the supply of green space remain static or even decline. Given current trends in favour of urban densification, councils should have a working estimate of the environmental services provided by private green spaces. If densification means a reduction in existing green spaces, they should indicate how some of their services can be maintained, if necessary by alternative means (e.g. new street plantings or roof gardens).

Councils need to lay out how they expect the higher temperatures and changing precipitation patterns of a changing climate to affect urban areas and what 'hard' and 'green' infrastructure will be deployed to manage those changes.

Factoring in these trade-offs and the impact of climate change, communities need to determine:

- the 'right' amount of urban green space to meet their needs
- the services (e.g. environmental, recreational, amenity and cultural) they want their green spaces and green infrastructure to provide
- the quality and composition of those green spaces
- where those spaces should be located.

In other words, councils need a benchmark of the type and mix of green spaces communities aspire to and the minimum level of services that the community wants protected.

Some councils already do a good job of planning for urban green spaces; others do not, yet. The declining trends observed in this report and the inevitable impact of climate change mean that even proactive councils cannot rest on their laurels. Being explicit about the green space outcomes being aimed for over time is essential if we are to avoid inadvertently dropping below the community's bottom line for green space provision before that line has even been defined.

To be realised, policies and service levels relating to green spaces must be explicitly reflected in councils' key operational documents (e.g. district, regional and long-term plans).[1]

**Recommendation 2. Amend the Local Government Act 2002 and the National Policy Statement on Urban Development to ensure that urban green space is one of the mandatory things councils must plan and provide for.**

Planning for and providing urban green spaces should not be optional. Both the resource management and local government systems need to make it clear that it is a core function that councils are expected to perform and perform well.

Urban green space provides many of the same services that traditional forms of infrastructure do. It regulates and filters stormwater flows. It provides places to exercise and socialise in the same way that roads and community facilities do. But in providing those services, green spaces simultaneously provide a suite of benefits – environmental, social and cultural – that traditional infrastructure cannot provide.

Despite that, territorial authorities are not required to plan for or provide public green space in the same way they are required to for roads or three waters infrastructure. As discussed in chapter three of this report, public green space does not have to be included in the infrastructure strategies that councils are required to prepare under the Local Government Act. Similarly, it does not form part of the 'development infrastructure' that councils are required to provide under the National Policy Statement on Urban Development.

[1] Or regional spatial plans and regional natural and built environment plans if the proposed new resource management legislation is enacted.

Throughout this investigation, council staff, green space professionals and even developers have expressed frustration with this 'optionality' that, in effect, means that green space is accorded a lower priority than other forms of infrastructure. This manifests itself in various ways, including the general absence of park and reserve requirements in subdivision codes of practice, a tendency to see parks and reserves as a source of cost savings (or a source of additional revenues in the case of 'asset rationalisation' processes), and a reticence to use powers under the Public Works Act to acquire land for peri-urban parks well ahead of time.

The playing field should be levelled (pun intended). Changes should be made to both the Local Government Act and the National Policy Statement on Urban Development to give equal priority to green spaces and network infrastructure. Should a future amendment to the Local Government Act seek once again to make explicit the core services of local government, I recommend that provision of urban green spaces be included as one such core service.

## Monitoring how green space in our cities is changing, and understanding what that means in terms of the services it provides

**Recommendation 3: The Ministry for the Environment – Manatū Mō Te Taiao should require councils to regularly monitor and measure urban green space using a standardised and consistent approach.**

**Recommendation 4: The Ministry for the Environment – Manatū Mō Te Taiao should provide guidance on how that monitoring should be carried so that a consistent and comparable approach is applied across councils.**

Regular monitoring is necessary if we are to know how green space is changing in our cities. Without that understanding, councils will be able to say little about whether the various services that green spaces provide are being maintained.

Some councils already monitor changes in urban land use. Auckland Council, for example, is able to accurately map how the distribution and type of green space across Auckland has changed since 2008. Recent improvements in the quality – and cost – of remote sensing technology and machine learning processes means there is little excuse for other councils not to follow suit.

However, many councils lack the ability to track changes through time, with some being focused on just a single aspect of the green space network (e.g. tree canopy cover). In addition, existing monitoring efforts are not standardised, making it difficult to compare results across cities.

Under the draft National Policy Statement for Indigenous Biodiversity, regional councils – in collaboration with territorial authorities – will be required to "assess the percentage of indigenous vegetation cover in each of its urban environments". That requirement could easily be extended to include non-indigenous vegetation and green space more generally. Alternatively, a monitoring requirement could be included in the National Policy Statement on Urban Development as green spaces are an important component of well-functioning urban environments.

In order to ensure consistency across regions and allow for comparison, the Ministry for the Environment should provide advice on how monitoring should be carried out. At a minimum, that advice should extend to (i) the spatial and temporal resolution of the imagery to be captured, (ii) how urban boundaries are to be defined, and (iii) the classes of vegetation that are captured and reported on. Over time, this guidance should become more sophisticated to include measures of the biophysical and other services provided by green spaces.

**Recommendation 5: The Ministry of Business, Innovation and Employment – Hīkina Whakatutuki and the Ministry for the Environment – Manatū Mō Te Taiao should ensure that publicly funded research extends to:**

**a) improving our understanding of the biophysical functions provided by urban green space; and**

**b) developing the tools needed to measure, monitor and manage urban green spaces.**

Monitoring how urban green space is changing is important. But what ultimately matters is how any continued reduction in the quantity and quality of green space will detract from the environmental services it provides. It is only with that knowledge that councils – and the communities they serve – can make informed decisions about the trade-offs associated with urban development and associated land use change.

Understanding the consequences of removing urban green space is easier said than done. The services it provides are both hard to quantify and difficult to disentangle. Furthermore, they are place specific and occur at multiple scales, from an individual backyard to an entire city.

Given the challenges posed by climate change, it is important that we better understand the cooling and stormwater regulation functions of urban green space. As shown in chapter four of this report, it is possible to draw general conclusions about these on the basis of existing scientific understanding. Finer-grained conclusions – around the radiative effects of concrete versus green walls or the locus of the cooling effect provided by trees, for example – are more challenging.

Much of the existing evidence base originates from research undertaken abroad with uncertain applicability to the New Zealand context (i.e. climate, vegetation etc). This knowledge gap needs to be addressed.[2] And we need tools to translate this knowledge into formats that councils can use to be much more precisely aware of the trade-offs they are making in the way they manage their urban green spaces.[3]

[2] For example, Jang and Woo (2022) recently highlighted the need for more research to better understand which native trees will respond to changing urban environments in New Zealand.

[3] For example, i-Tree is a well-developed suite of online tools that can estimate various biophysical benefits provided by trees in cities (see www.itreetools.org). The tool's use is still at the research and development stage here in New Zealand but would appear to offer considerable potential for quantifying what green spaces provide.

## Developing ways to improve the quantity and quality of green space in our cities



Monitoring and planning for urban green space and its benefits is one thing. Delivering on that vision is another. The following recommendations focus on the need to develop a range of workable options for communities wishing to improve the quantity and quality of green space, both in existing urban areas and ones yet to be developed.

### Existing urban areas

**Recommendation 6: Councils and relevant government agencies (e.g. Kāinga Ora – Homes and Communities, Waka Kotahi NZ Transport Agency, Ministry of Education – Te Tāhuhu o te Mātauranga) should implement policies to improve the quality and/or quantity of green space in suburbs where it is in decline or in otherwise short supply. At a minimum, policies should be evaluated that:**

a) ***on publicly owned land*, improve green space in parts of the road corridor, in existing parks and schools, and in other 'forgotten' or neglected corners of public land**

b) ***on privately owned land*, provide incentives for landowners and developers to retain and provide shrubs and trees (rather than just grass) in yards and to encourage more vertical development (provided green space is preserved or significant new green space is provided for).**

This report has found that private green space in existing suburbs is declining. In addition, some councils are struggling to retrofit new areas of public green space into existing suburbs. Looking forward, the net effect is likely to be more people relying more heavily on a substantially smaller network of green space.

This dynamic is occurring against the backdrop of a changing climate that is likely to make urban spaces hotter and having to withstand more extreme rainfall events. Improving the quality of existing areas of green space in existing suburbs is one way that councils could respond to these challenges. This could include increasing canopy cover, replacing grass with shrubs and trees and replacing asphalt or concrete with some form of vegetation.

#### Options for improving public green space quality in existing suburbs

**Road corridors** represent an obvious area for improvement. These are publicly owned, account for 15–20% of the surface of our cities and provide a network that parks and reserves cannot. The analysis undertaken for this report found that somewhere between 30 and 40% of the road corridor can already be characterised as 'green'. But much of this is little more than grass, which offers limited benefits on its own.

Known barriers to revegetating the road corridor include competing claims for this space (such as car parking and driveways), concern over vegetation interfering with utilities and even issues with street safety. Even acknowledging those problems, the generous width of the road corridor in many existing suburbs and the prevalence of grass berms mean there is still much potential for improvement.

One action that could be employed in the short term is to plant some of the existing grass berms with more diverse vegetation. There will be room to plant appropriately sized tree species in some existing grass berms even with the current configuration of underground infrastructure to look out for. Simple tree pits or trenches might be able to be added to provide soil volume. In other areas, smaller shrubs and plants that have shallower roots might be added. It may also be possible to allow grasses and tussocks to grow without being mown so regularly too. The scope for such simple upgrades of the grassy berms would appear to be considerable and should be further explored. Another short-term strategy could be to replace concrete or asphalt footpaths with permeable paving solutions.

More transformative changes are possible if the entire road corridor is to be reconfigured. Because road corridors are public spaces, it makes sense to think about how people may wish to use them in the future and start to incorporate green improvements as part of the rebuilding. A shadeless inner-city street today with two footpaths, two grassy berms, two rows of carparks, two lanes for traffic and a maze of underground pipes and cables could potentially be reconfigured to contain one footpath, one cycleway, one lane for slow traffic (with passing bays), parking for cars, raingardens, space for large trees and perhaps even community gardens.

In terms of improving the **existing parks** within city suburbs, many options exist. In the short term, simply adding patches of larger shrubs and trees may be possible. Totally reconfiguring the layout of an entire park to better reflect the needs of the nearby community is at the other end of the spectrum.[4] Assessing the community's needs could reveal that less grassy areas are required for sports, and more varied uses and functions are desired. Habitat for native species, areas available for resource use by kaitiaki, productive gardens and orchards, and ponds and wetlands are all potentially able to be added within the footprint of existing public parks. The new award-winning park being constructed at Scott Point, Auckland, is designed to provide many of these things in a greenfield situation.[5] While this kind of blank-slate park development is unlikely to occur in brownfield areas, it is still possible to make improvements to these public areas. Adding small patches of trees, shrubs or wetlands may even be possible without encroaching on any existing sports fields.

There will be potential to provide more green space on other publicly owned land too. For example, trees and gardens could be added to car parks, or buildings might be retrofitted with green walls or roofs (underlying structure allowing). Some of these options are occurring – Auckland's central library has recently had a green roof fitted.[6]

## Options for improving private green space quality in existing suburbs

Ensuring that the area of land that is *not* built on continues to be able to provide environmental services should be a priority. The recently promulgated MDRS require 20% of the area of a section to be retained as "landscaped area". However, there is little standing in the way of developers meeting that requirement by planting narrow strips of grass along the periphery of a lot.

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[4] Bolleter and Ramalho, 2020.

[5] Auckland Council, no date b.

[6] Auckland Council, no date a.

Auckland Council and Hamilton City Council are attempting to address that issue by including rules on minimum tree provision in the plan changes that implement the MDRS. There is also scope to expand the use of financial incentives that encourage the retention (and provision) of shrubs and trees on private land. Auckland Council, for example, modulates the development (stormwater) contribution it charges developers according to how much of the site is sealed.[7] Similarly, Christchurch City Council has proposed introducing a financial contribution with reduced charges for developers who retain existing trees.

So-called 'green-score' accreditation schemes also offer a way forward. These have been implemented in a number of large cities overseas (including Berlin, Seattle and soon London) as a way of encouraging better green space outcomes on private land. Recent research here in New Zealand exploring the potential for scoring backyard biodiversity may also help improve private green space outcomes.[8]

The retention (and planting) of shrubs and trees on private land does not need to stifle housing supply. Medium-density developments currently account for more than 60% of the new dwellings being built in New Zealand cities. Multi-storey apartments, by contrast, account for less than 10% (see the overview to this report). Encouraging more development 'upwards' would allow more private green space to be retained. Areas to consider include addressing some of the barriers such as differential consenting regimes, engineering requirements, and concerns about apartment living (such as body corporate regimes).

## How can these improvements be funded?

One mechanism to help fund public green space upgrades is for councils to require developers who go below a certain level of private green space to pay for the loss (through a development or financial contribution, for example). The revenue could enable councils to improve the quality of public green spaces nearby (ideally with a strong emphasis on proximity to maximise the offsetting function of these public areas).

Alternatively, councils could impose a hypothecated rates levy city-wide specially aimed at improving and maintaining high quality public green spaces. This would make the value, functionality and cost of providing green space transparent. Such a mechanism could be used to improve equitable access to green space by focusing spending on existing suburbs with the lowest quality green space. It could equally be used to improve private green spaces where that will contribute a wider public benefit.

Levies can also be used on a 'targeted' basis to enable local communities to secure public green space upgrades that are paid for by an additional rate. This approach sees the costs and benefits being assessed on the basis of distinct locations. Targeted levies can enable suburban communities to make improvements to public green space that are tailored to projects the community has indicated a wish to support.

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[7] Auckland Council, 2021, p.20.

[8] van Heezik et al., 2023.

## Future urban areas

**Recommendation 7: Councils should identify, and consider purchasing, peri-urban land for large areas of public green space earlier in the planning process.**

**Recommendation 8: Central government could help to enable peri-urban public green space provision by:**

**a) clarifying councils' ability to acquire land for future public green space using the compulsory acquisition powers provided by the Public Works Act 1981**

**b) enabling councils to use value uplift taxes to help pay for bulk public infrastructure (including the land required for larger areas of public green space).**

Peri-urban areas offer a blank canvas that existing urban areas do not. The absence of pre-existing infrastructure and the relatively tightly held pattern of land ownership gives planners, and the communities they serve, the freedom to create the suburbs they want right from the outset. In addition to laying out arterial roads and trunk water infrastructure, councils can also identify locations for larger areas of public green space.

Not all types of public green space can be located early in the development process. Pocket parks and local parks need to be located relative to a network of local roads, the layout of which is not generally confirmed until the subdivision consent stage. Larger parks and reserves, by contrast, can act as a 'cornerstone' or 'green lung' around which residential and commercial development can expand.

Most of New Zealand's cities contain large parks that were set aside early in their development. Places like the Auckland Domain (75 hectares), Hamilton's Lake Domain (101 hectares), the Wellington Botanic Gardens (25 hectares) and Hagley Park (164 hectares) continue to offer a wide range of biophysical and recreational benefits to inner-city residents today. It is inconceivable that they would ever be traded away.

But as this report has documented, most councils appear to be struggling to create large new public green spaces for tomorrow's urban dwellers.[9] That is potentially problematic given the simultaneous (and ongoing) reduction in the size of private yards and sections.

The upfront cost of peri-urban land is a major barrier to the provision of larger parks. One way for councils to reduce that cost is to be more proactive about identifying – *and acquiring* – the land required well ahead of time (i.e. before expectations of up-zoning and value uplift have become incorporated into market prices). While there are funding and financing barriers to such an approach, the alternative of waiting for land to be up-zoned – and paying three to four times the price for it[10] – is not particularly attractive either.

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[9] See chapter two. Most councils do not appear to be trying to set aside larger areas of public green space. Of the provision policies summarised in chapter three, only Tauranga City Council's contain a formal target for parks larger than 10 hectares in size.

[10] Auckland Council, 2022j – GeoMaps, property – revaluation layer; MR Cagney, 2022, table 2.

Not every parcel of peri-urban land desired by council for future public green space will be available to buy on a 'willing seller – willing buyer' basis prior to up-zoning. Some landowners may prefer to hold out in expectation of future value uplift. Other landowners may have little interest in selling at any price, preferring to continue with their existing use of the land.

When it comes to traditional forms of infrastructure, this issue is often solved through designations (under the RMA) and the compulsory acquisition powers (under the Public Works Act) that follow. The legal position for parks and reserves is more ambiguous. While not explicit, both sets of powers appear to be available for the purpose of acquiring land for future public green space.[11] This should be clarified because there is, in principle, no reason to treat future parks and reserves as being in any way different from other 'hard' infrastructure.

Whether such an approach is fair is another matter. In most situations, the land required for a large peri-urban park or reserve will fall disproportionately on a particular property, and early compulsory acquisition would deprive the landowner of future windfall gains associated with up-zoning. A hard-line view would be that the landowner is made no worse off relative to their previous circumstances (having been compensated under the Public Works Act).[12] That said, they would very likely be worse off relative to neighbours and other landowners in the broader development area. As such, a fairer approach would be to defer the acquisition of land for large peri-urban parks until after up-zoning has occurred and give councils a funding instrument that would help to cover the increased cost of acquiring land.

Value uplift taxes have particular potential in this respect and should be explored further. The windfall gains associated with up-zoning of rural land result from public policy decisions rather than any effort on behalf of the landowner. Given that, there is an argument that some share of that gain should be used to provide the bulk infrastructure (public green space included) that makes urban development possible. The devil is in the detail of course, but it is worth noting that the Australian state of Victoria is about to implement such a scheme.[13]

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[11] See chapter three. Under the Resource Management Act 1991 (RMA), territorial authorities can issue a notice of requirement for a designation for "a public work within its district and for which it has financial responsibility" (s 168A). The definition of public work is based on "eligible infrastructure", which includes community facilities and, in turn, reserves (RMA, s 66; Infrastructure Funding and Financing Act, s 8). Under the Public Works Act, territorial authorities are "empowered to acquire … any land required for a local work for which it has financial responsibility". The definition of "local work" is again based on "eligible infrastructure", which, as discussed, includes reserves.

[12] Under the Public Works Act, landowners are entitled to compensation, the value of which is "taken to be that amount which the land … if sold in the open market by a willing seller to a willing buyer on the specified date might be expected to realise" (s 16).

[13] State Revenue Office Victoria, 2022.

## Investigate how we treat urban soils



**The Parliamentary Commissioner for the Environment will undertake a short follow-up investigation into the fate of urban soil as part of the subdivision and development process and who is responsible for the environmental impact of these practices.**

During the course of this investigation, it has been drawn to my attention that residential development often involves the almost complete removal of soil from the site in question. Depending on how pervasive that practice is, it could have long-lasting consequences for the permeability of ground in urban areas, how much water it can store, and what types of vegetation will grow in it. It is a matter of concern if the amount of soil left after development can support nothing more than grass or low shrubs. An increase in hot days and extreme weather events will place a premium on shade and water retention.

As a follow-up to this report, I am intending to take a closer look at this issue to determine:

- how widespread this practice is
- what the underlying regulatory or economic drivers are
- what the long-term consequences of this development practice might be.

I would welcome any views or suggestions on the direction my enquiries should take.

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*Loxsoma cunninghamii*

# Appendix: Limitations and error assessment

## Limitations

There are at least four potentially significant limitations associated with the green space analyses undertaken for this report (Table A.1).

**Table A.1: Significant limitations associated with green space analyses undertaken for this report.**

| Direct detection (DD) | Subtraction-based (SB) |
|---|---|
| Defining the rural–urban boundary | |
| Inaccurate object detection owing to variable image quality | |
| | Aligning population census data |
| | Detecting 'grey' surfaces |

The first, which affects both the direct detection and subtraction-based approaches, is that the process used to define rural–urban boundaries relied heavily on analyst judgement. This matters because the urban boundary that is chosen for a particular city and time period affects the amount of green space that exists within it.[1] For the most part, the 'physical form' definition used in this report was easily applied – the transition between urban and rural areas was abrupt and easy to delineate. Sometimes the urban–rural transition was more diffuse,[2] and in these instances care was taken to ensure that decisions on boundary locations were made in a consistent way.

[1] For example, a boundary situated on the outer margin of a 'large-lot' rural residential zone will incorporate much more private green space than one on the inner margin.

[2] This is reasonably common in the images from the 1940s, when cities were expanding rapidly and not necessarily in a coherent planned way. Diffuse urban boundaries also exist today, perhaps most notably in some of Wellington's peri-urban hill suburbs.

The second limitation, which also affects both the direct detection and subtraction-based approaches, relates to the quality of the aerial photography used. When it comes to the direct detection analysis, the infrared photography available for Auckland and Greater Wellington has an inferior spatial resolution to that in Hamilton. That creates challenges for the automated detection process used to map green space, and results in some green features being incorrectly mapped as grey (and vice versa). When it comes to the subtraction-based approach, the photography available for earlier periods is often 'grainy' or lacks contrast. That creates challenges for the automated detection process used to map buildings in earlier time periods.

The third limitation, which relates solely to the subtraction-based approach, concerns the population data available for the earliest time horizon. Census data in the 1940s and 1950s were typically collected at the 'borough' or 'district' level (rather than the meshblocks that are used today). That makes it difficult to align population data with the urban limits defined as part of this study and means that the green space per-capita results for the 1940s may contain considerable error.

The fourth limitation also relates solely to the subtraction-based approach and concerns the accuracy of the manual processes used to map the features to be 'subtracted': industrial and commercial zones; transport corridors; and buildings. For the most recent time horizon, the following issues arose.

- Industrial and commercial zones for the current period were mapped using zoning information contained in district plans. This is problematic in situations where development lags what zoning rules allow for (e.g. where peri-urban land is zoned for industrial activities but remains as undeveloped green space). Considerable effort was made to manually adjust zoning maps to reflect this.
- Roads were mapped using information from district plans and Toitū Te Whenua – Land Information New Zealand. Both datasets represent the legal road corridor, which includes some green space in the form of berms, median strips and roundabouts, and the trees that these features often contain. Because these features were removed from the subtraction-based analysis, the amount of overall green space will be underestimated.
- The process used to detect and map buildings was unable to delineate many of the sealed areas commonly associated with buildings: driveways, off-street carparks, patios, pathways, swimming pools, school yards etc. Collectively, these 'grey' areas account for a significant amount of land, particularly in residential areas. These features were included as green space by the subtraction-based analysis, and will result in green space being overestimated.

The magnitude of the error associated with the issues affecting the subtraction-based analysis almost certainly vary through time. In some cases, the error is likely to be greater for earlier periods. The lack of zoning information for historical periods made mapping industrial areas and road corridors as they existed in the 1940s and 1980s challenging, for example. It also made capturing historical ownership of green space difficult.[3] In other cases, error is likely to be greater for the current period. This is particularly relevant for sealed grey spaces – driveways, patios, pools etc – which are far more prevalent today than in the 1940s.

[3] In both cases, modern zoning maps were manually adjusted to account for the land-use change that has taken place over time. This exercise was undertaken with considerable care, but is probably imperfect given the size of the areas to be covered.

## Quantifying the error

Two approaches were used to get a sense of the magnitude of the error associated with the above limitations (Table A.2).

The first approach was point sampling. One thousand points were randomly selected for each city and time period of interest, and each point was coded manually through visual inspection of the underlying aerial imagery. A comparison was then made with the results of the primary analysis.

The second approach was polygon sampling. Thirty 150-metre by 150-metre areas were randomly selected for each time period in Auckland, and the contents of each area were manually digitised into polygons on the basis of the underlying imagery. Again, that allowed a comparison to be made with the results of the primary analysis.

**Table A.2: Summary of error assessment strategy.**

| | Auckland | Hamilton | Greater Wellington |
|---|---|---|---|
| **2010s** | Point sampling (DD – 2011)<br>Point sampling (SB – 2017)<br>Polygon sampling (SB – 2017) | Point sampling (DD – 2021) | Point sampling (DD – 2021) |
| **1980s** | Point sampling (SB – 1980)<br>Polygon sampling (SB – 1980) | | |
| **1940s** | Point sampling (SB – 1940)<br>Polygon sampling (SB – 1940) | | |

Note: DD = direct detection; SB = subtraction-based.

### Error assessment: green space current state

Visual inspection of the outputs produced by the direct detection analysis suggests they are of a high quality. Mapped green space layers closely align with the green space visible in the underlying imagery, and even relatively narrow or small features (such as vegetated median strips or individual street trees) were able to be resolved.

The point-based error assessment supports the accuracy of the direct detection results. As shown in Table A.3, upwards of 90% of the points sampled in Auckland, Hamilton and Greater Wellington were classified correctly. Errors were observed in both directions in roughly the same proportions in Auckland and Hamilton – that is, the number of green features that were incorrectly coded as grey was similar to the number of grey features that were incorrectly coded as green. In Wellington there was more of a bias towards incorrectly classifying grey features as green, suggesting an overestimation of green space.

Where direct detection did misclassify features, the following factors were often involved:

- Dry turf: In some cases, this was misclassified as a sealed surface.
- Green or red painted roofs and vehicles: In some cases, these were misclassified as green space.
- Edge effects: Building shadows and sharp transitions between green and grey space occasionally resulted in misclassifications. The latter is particularly pronounced in Wellington, where sealed surfaces immediately adjacent to dense vegetation were misclassified as green space (due to a 'bleeding' of the infrared signal).

**Table A.3: Results of point sampling error assessment: current state.**

| | Auckland | | Hamilton | | Greater Wellington | |
|---|---|---|---|---|---|---|
| | Green (manual) | Not green (manual) | Green (manual) | Not green (manual) | Green (manual) | Not green (manual) |
| **Green (direct detection)** | 458 | 49 | 395 | 32 | 666 | 41 |
| **Not green (direct detection)** | 39 | 392 | 39 | 441 | 9 | 260 |
| **Sample size** | 938 | | 907 | | 976 | |
| **Correctly classified** | 91% | | 92% | | 95% | |

## Error assessment: green space temporal change

As noted above, there are a number of important sources of error associated with the subtraction-based approach that has been used to quantify changes in urban green space through time. Some of these – such as the classification of driveways and some other sealed features as green space – serve to bias green space results upwards. Other sources of error – the classification of vegetated berms as sealed road, for example – act in the opposite direction.

As shown in Table A.4, the subtraction-based approach produced correct results for around 80% of the points sampled across three time horizons in Auckland. In general, there was a fairly even balance between features incorrectly classified as green space and those incorrectly classified as built upon or grey.

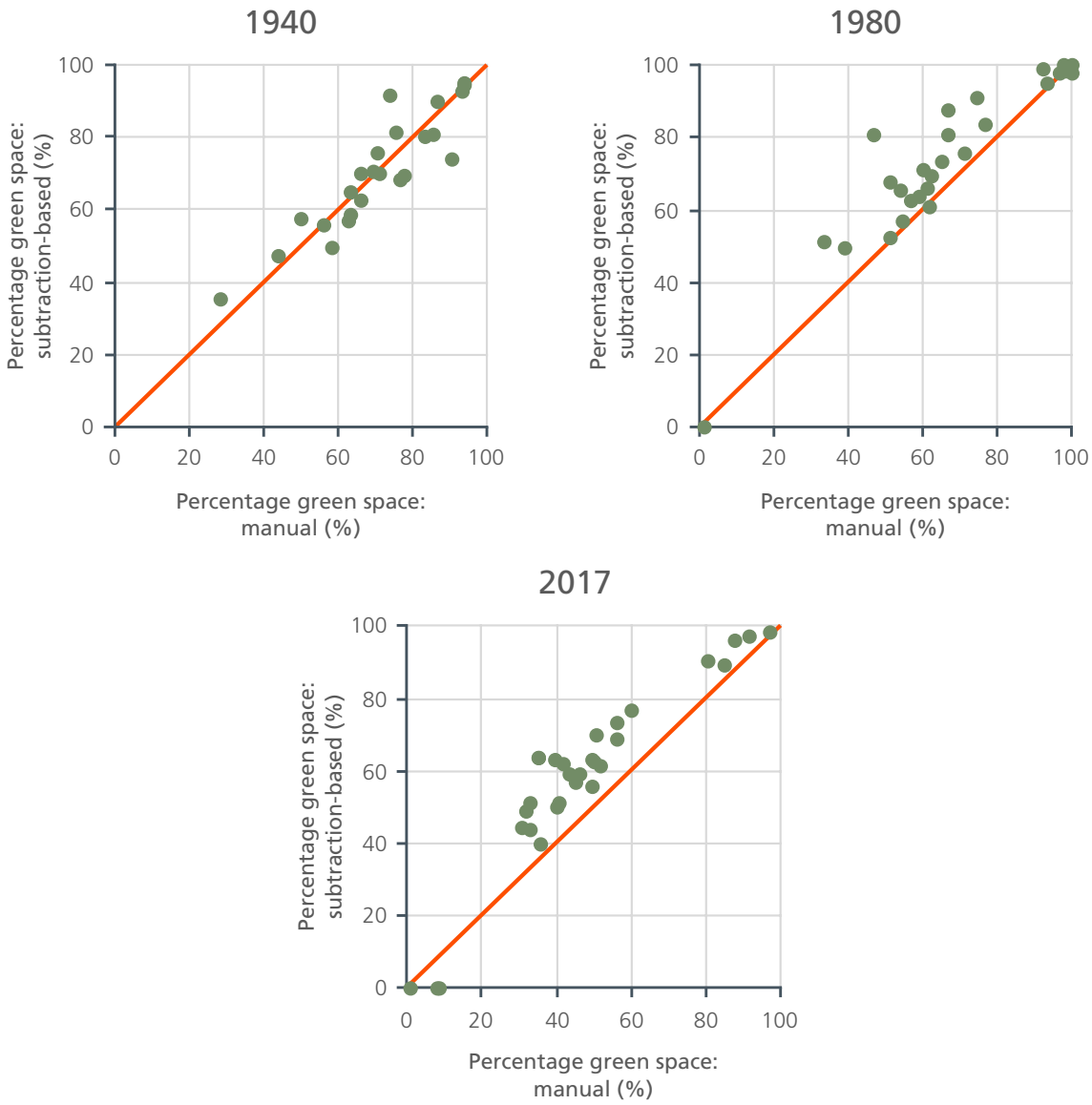
**Table A.4: Results of point sampling error assessment for green space analysis: temporal change.**

| | Auckland (1940) | | Auckland (1980) | | Auckland (2017) | |
|---|---|---|---|---|---|---|
| | Green (manual) | Not green (manual) | Green (manual) | Not green (manual) | Green (manual) | Not green (manual) |
| **Green (subtraction based)** | 583 | 75 | 553 | 94 | 433 | 109 |
| **Not green (subtraction based)** | 87 | 220 | 76 | 260 | 85 | 351 |
| **Sample size** | 965 | | 983 | | 978 | |
| **Correctly classified** | 83% | | 83% | | 80% | |

Polygon sampling was used to better understand whether the results of the temporal analysis were biased (and in what direction).

The results of that exercise are shown in Figure A.1. The subtraction-based approach performs well for the 1940s time horizon, but increasingly overestimates green space in later periods. That pattern is consistent with the readily observable increase in sealed driveways, off-street carparks, patios and pathways, which, as discussed above, were generally mapped as green space for the temporal analysis.

In short, the decline of urban green space presented in this report is very likely a conservative estimate of what has actually transpired.




Source: PCE

**Figure A.1: Comparison of reported results and manual polygon sampling, Auckland 1940, 1980, 2017.**

*Pteris carsei*

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This report has been produced pursuant to subsections 16(1)(a) to (c) of the Environment Act 1986. The Parliamentary Commissioner for the Environment is an independent Officer of Parliament, with functions and powers set out in the Environment Act 1986. His role allows an opportunity to provide Members of Parliament with independent advice in their consideration of matters that may have impacts on the environment.



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