Herne Bay

Cox's Bay

0 195 390 780 Metres

Centre Entrance

Large and High Accessibility Town Centre

Property Parcel

Auckland Unitary Plan Zones

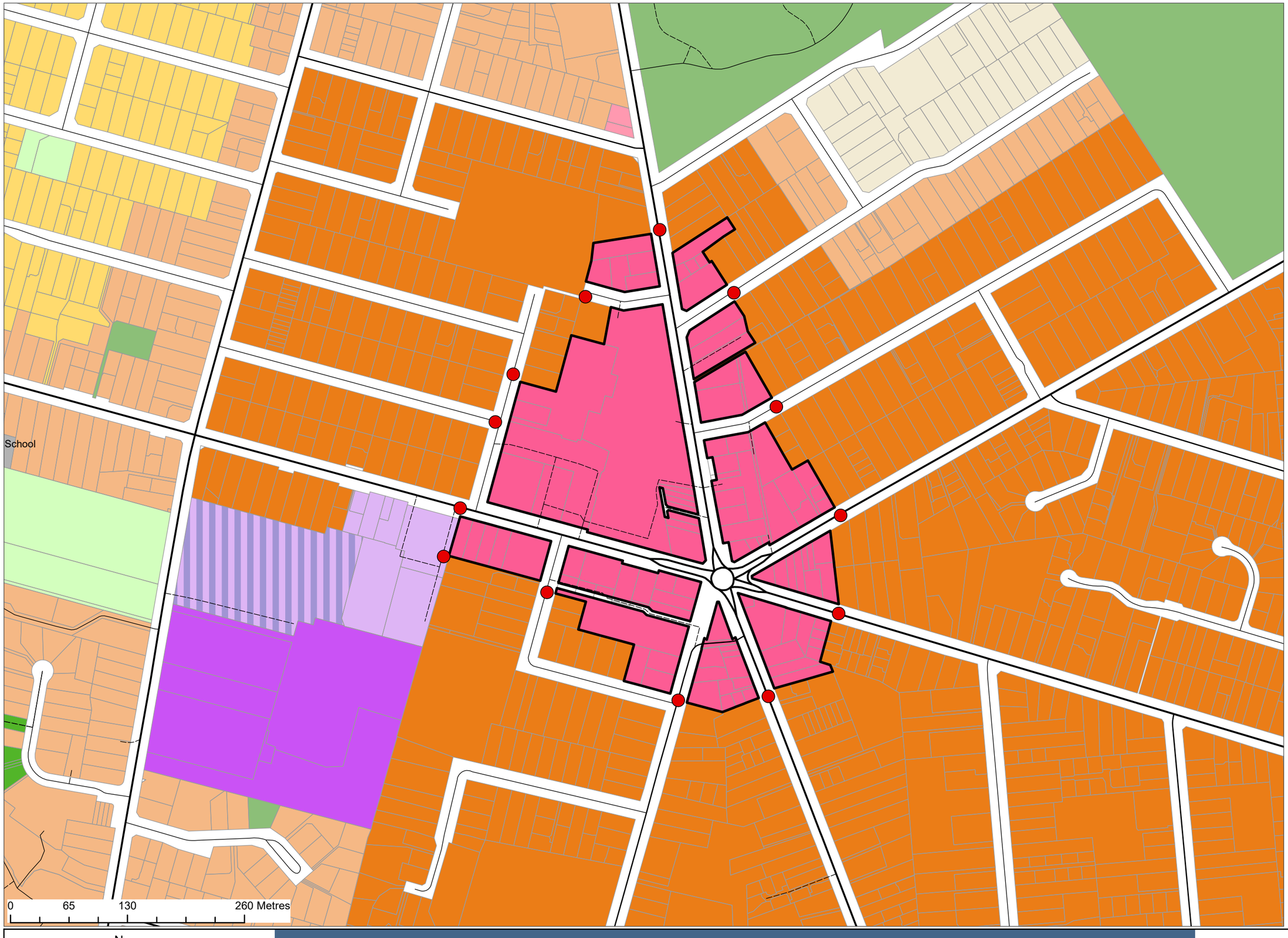
- Residential - Large Lot Zone
- Residential - Rural and Coastal Settlement Zone
- Residential - Single House Zone
- Residential - Mixed Housing Suburban Zone
- Residential - Mixed Housing Urban Zone
- Residential -Terrace Housing and Apartment Buildings Zone
- Open Space - Conservation Zone
- Open Space - Informal Recreation Zone
- Open Space - Sport and Active Recreation Zone
- Open Space - Civic Spaces Zone
- Open Space - Community Zone
- Business - City Centre Zone
- Business - Metropolitan Centre Zone
- Business - Town Centre Zone
- Business - Local Centre Zone
- Business - Neighbourhood Centre Zone
- Business - Mixed Use Zone
- Business - General Business Zone
- Business - Business Park Zone
- Business - Heavy Industry Zone
- Business - Light Industry Zone
- Future Urban Zone
- Green Infrastructure Corridor (Operative in some Special Housing Areas)
- Rural - Rural Production Zone
- Rural - Mixed Rural Zone
- Rural - Rural Coastal Zone
- Rural - Rural Conservation Zone
- Rural - Countryside Living Zone
- Rural - Waitakere Foothills Zone
- Rural - Waitakere Ranges Zone
- Strategic Transport Corridor Zone
- Special Purpose Zone
- Coastal - General Coastal Marine Zone [rcp]
- Coastal - Marina Zone [rcp/dp]
- Coastal - Mooring Zone [rcp]
- Coastal - Minor Port Zone [rcp/dp]
- Coastal - Ferry Terminal Zone [rcp/dp]
- Coastal - Defence Zone [rcp]
- Coastal - Coastal Transition Zone
- Water [i]
- Hauraki Gulf Islands
- Road [i]

N

Ponsonby Town Centre

Auckland Council
Te Kaunihera o Tāmaki Makaurau

Plans and Places



Centre Entrance
Large and High Accessibility Town Centre
Property Parcel

Auckland Unitary Plan Zones

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- Coastal - Ferry Terminal Zone [rcp/dp]
- Coastal - Defence Zone [rcp]
- Coastal - Coastal Transition Zone
- Water [i]
- Hauraki Gulf Islands
- Road [i]

N

Royal Oak Town Centre

Auckland Council
Te Kaunihera o Tāmaki Makaurau
Plans and Places

School

0 65 130 260 Metres

N

Centre Entrance
Large and High Accessibility Town Centre
Property Parcel

Auckland Unitary Plan Zones

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- Business - General Business Zone
- Business - Business Park Zone
- Business - Heavy Industry Zone
- Business - Light Industry Zone
- Future Urban Zone
- Green Infrastructure Corridor (Operative in some Special Housing Areas)
- Rural - Rural Production Zone
- Rural - Mixed Rural Zone
- Rural - Rural Coastal Zone
- Rural - Rural Conservation Zone
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- Special Purpose Zone
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- Coastal - Ferry Terminal Zone [rcp/dp]
- Coastal - Defence Zone [rcp]
- Coastal - Coastal Transition Zone
- Water [i]
- Hauraki Gulf Islands
- Road [i]

St Lukes Town Centre

Auckland Council
Te Kaunihera o Tāmaki Makaurau
Plans and Places

School

0 80 160 320 Metres

N

Centre Entrance
Large and High Accessibility Town Centre
Property Parcel

Auckland Unitary Plan Zones

- Residential - Large Lot Zone
- Residential - Rural and Coastal Settlement Zone
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- Residential - Mixed Housing Urban Zone
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- Rural - Rural Coastal Zone
- Rural - Rural Conservation Zone
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- Rural - Waitakere Ranges Zone
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- Road [i]

Stoddard Rd Town Centre

Auckland Council
Te Kaunihera o Tamaki Makaurau
Plans and Places

Appendix 17

Equivalent zones: Auckland Council District Plan - Hauraki Gulf Islands Section

Hauraki Gulf Islands Section: zone	Auckland Unitary Plan: 'Best fit' zone	Comment	National Planning Standards: 'Best fit' zone	Comment
Land unit – Island Residential 1 (traditional residential)	Residential - Rural and Coastal Settlement Zone	HGI zone is described "close to the commercial centre or villages", "generally low intensity" and "highly modified, open and spacious landscape". The objectives and policies refer to onsite wastewater disposal. The minimum site area for subdivision is 1,500m^2. The closest match in the Unitary Plan would be the Rural and Coastal Settlement zone as the objectives and policies of this zone refer to a "rural and coastal character" and the need for onsite wastewater. The minimum site size for subdivision is 2,500m^2. Both provide for a limited range of similar activities and have the same maximum height control. Both also recognise servicing and infrastructure constraints.	Settlement zone	The closest match in the National planning standard is the Settlement zone which has the following definition: "Areas used predominantly for a cluster of residential, commercial, light industrial and/or community activities that are located in rural areas or coastal environments".
Land unit – Island Residential 2 (bush residential)	Residential - Large Lot Zone	HGI zone is described as generally adjoining Island residential 1, having moderate to steep slopes, low intensity development and heavy bush cover. The objectives and policies refer to retaining indigenous vegetation cover. The minimum size of subdivision is 2000m^2. The closest match in the Unitary Plan would be the Residential - Large Lot which objectives and policies refer to development maintaining the area's "spacious landscape character, landscape qualities and natural features". The minimum size of subdivision is 4000m^2.	Large lot residential zone	The closest match in the National planning standard is Large lot residential zone which has the definition: "Areas used predominantly for residential activities and buildings such as detached houses on lots larger than those of the Low density residential and General residential zones, and where there are particular landscape characteristics, physical limitations or other constraints to more intensive development"
Commercial 1 (Oneroa village)	Business – Neighbourhood Centre Zone	HGI zone is described as providing generally small scale retail and other commercial activities for relatively high volumes of traffic. Oneroa has a stronger tourism function with cafes, shops, museum, art gallery etc. The island's only library is also located at Oneroa. The objectives and policies enable a vibrant, varied and safe retail environment and allow appropriate commercial growth.	Neighbourhood centre zone	The closest match in the National planning standard is the Neighbourhood centre zone which has the definition: "Areas used predominantly for small-scale commercial and community activities that service the needs of the

Hauraki Gulf Islands Section: zone	Auckland Unitary Plan: 'Best fit' zone	Comment	National Planning Standards: 'Best fit' zone	Comment
		The AUPs Business - Neighbourhood Centre Zone applies to single corner stores or small blocks of shops which provide residents and passers-by with daily retail and commercial service needs. The objectives and policies refer to the zone as "attractive environments and attract ongoing investment, promote commercial activity, and provide employment, housing and goods and services".		immediate residential neighbourhood."
Commercial 2 (Ostend village)	Business - Local Centre Zone	The HGI zone is seen as the administrative centre of Waiheke, with most sizes being greater than 1000m^2 with a mix of commercial, residential and community facilities. The main supermarket and council offices are located at Ostend. The objectives and policies enable and consolidate commercial and community facilities. The closest match in the Unitary Plan would be the Business – Local Centre Zone which provide for local convenience needs including local retail, commercial services, offices, food and beverage, and appropriately scaled supermarkets.	Local centre zone	The closest match in the National planning standard is the Local centre zone which has the definition: "Areas used predominantly for a range of commercial and community activities that service the needs of the residential catchment."
Commercial 3 (Local shops)	Business – Neighbourhood Centre Zone	This HGI zone is defined as having "a smaller scale than retail activities within the main commercial centres of Oneroa and Ostend". The objectives and policies provide for small scale retail, and certain non-retail activities, in close proximity to residential areas". The same as the HGIs commercial 1, the AUPs Business - Neighbourhood Centre Zone applies to single corner stores or small blocks of shops which provide residents and passers-by with daily retail and commercial service needs. The objectives and policies refer to the zone as "attractive environments and attract ongoing investment, promote commercial activity, and provide employment, housing and goods and services".	Neighbourhood centre zone	The closest match in the National planning standard is the Neighbourhood centre zone which has the definition: "Areas used predominantly for small-scale commercial and community activities that service the needs of the immediate residential neighbourhood."
Commercial 4 (visitor facilities)	Business – Neighbourhood Centre Zone	HGI zone is described as providing for visitor facilities and camping facilities (and restaurants as an D activity), while not providing for dwellings. The minimum size of subdivision is 1500m^2. While more restrictive in the activities than most of the AUP zones, the most closely aligned AUP zone would be Business	Neighbourhood centre zone	The closest match in the National planning standard is the Neighbourhood centre zone which has the definition: "Areas used predominantly for small-scale commercial and community activities that service the needs of the

Hauraki Gulf Islands Section: zone	Auckland Unitary Plan: 'Best fit' zone	Comment	National Planning Standards: 'Best fit' zone	Comment
		- Neighbourhood Centre Zone. This applies to single corner stores or small blocks of shops which provide residents and passers-by with daily retail and commercial service needs. The objectives and policies refer to the zone as "attractive environments and attract ongoing investment, promote commercial activity, and provide employment, housing and goods and services". While this zone does provide for visitors accommodation as a permitted activity, camping facilities are not provided in the activity table and are therefore a non-complying activity.		immediate residential neighbourhood."
Commercial 5 (industrial)	Business – Light Industry Zone Zone	The HGI land unit is to provide for and protecting low and medium intensity industrial activities, while ensuring adverse environmental effects are avoided or mitigated. The most closely related AUP zone would be the Business – Light Industry Zone, this is provides for industrial activities which no not generate odour, dust or noise.	Light industrial zone	The closest match in the National planning standard is the Light industrial zone which has the definition: "Areas used predominantly for a range of industrial activities, and associated activities, with adverse effects (such as noise, odour, dust, fumes and smoke) that are reasonable to residential activities sensitive to these effects"
Commercial 6 (quarry)	Special Purpose – Quarry Zone	The land unit provides for quarrying and associated activities, while protecting the amenity and character. The closely related AUP zone is the Special Purpose – Quarry zone which provides for significant mineral extraction activities.		No Special Purpose zone provided in the National Planning standard for quarrying
Commercial 7 (wharf)	Coastal – Ferry Terminal Zone	The HGIs Commercial 7 (wharf) provides for the operation of the wharf and associated transport and recreational facilities. This most closely aligns with the AUPs Coastal – Ferry Terminal zone which also provides for the operation of ferry terminal facilities.		No specific zone provided in the National Planning standard for wharves
Matiatia (gateway)	Business - Local Centre Zone	The land unit provides currently for a ferry terminal and surrounding transport facilities while the objectives and policies allow for a mix of activities including retail, offices and restaurants and cafes. Height of up to 8m in the mixed use portion of the area.	Local centre zone	The closest match in the National planning standard is the Local centre zone which has the definition: "Areas used predominantly for a range of

Hauraki Gulf Islands Section: zone	Auckland Unitary Plan: 'Best fit' zone	Comment	National Planning Standards: 'Best fit' zone	Comment
		As the wharf in the area only covers a small area while the rest of the area is intended for a mix of uses, this most closely aligns with the AUPs Business - Local Centre. This zone provides range of activities including for local convenience needs including local retail, commercial services, offices, food and beverages. The height of the Local Centre would need to be controlled to be aligned with the HGI height.		commercial and community activities that service the needs of the residential catchment."
Open space 1 (ecology and landscape)	Open Space – Informal Recreation Zone	The HGI zone is described as facilitating the use and enjoyment of local parks and esplanade reserves for passive recreation while protecting the visual amenity and ecological value of the land unit. The most closely related AUP zone is Open Space – Informal Recreation zone, which maintains the open and spacious character, amenity values and any historic, Mana Whenua, and natural values of the zone and provides for informal recreational activities.	Natural open space zone	The closest match in the National planning standard is the Natural open space zone which has the definition: "Areas where the natural environment is retained and activities, buildings and other structures are compatible with the characteristics of the zone."
Open space 2 (recreation and community facilities)	Open Space – Sport and Active Recreation Zone	The HGI zone is described for the use of active recreation and community activities while protecting the visual amenity values of the land unit. The most closely related AUP zone is Open Space – Sport and Active Recreation zone, which provides indoor and outdoor sport and active recreation and activities accessory to these activities.	Sport and active recreation zone	The closest match in the National planning standard is the Sport and active recreation zone which has the definition: "Areas used predominantly for a range of indoor and outdoor sport and active recreational activities and associated facilities and structures."
Open space 3 (Rangihoua Park)	Open Space – Sport and Active Recreation Zone	The HGI zone provides sport facilities (including golf, equestrian, tennis, mountain biking and playing fields), walking tracks, picnic spots, a cemetery and historic museum. The objectives and policies of the area is to maintain the enhance the ecological values and provide a wide range of recreational facilities.	Sport and active recreation zone	The closest match in the National planning standard is the Sport and active recreation zone which has the definition: "Areas used predominantly for a range of indoor and outdoor sport and active recreational activities and associated facilities and structures."

Hauraki Gulf Islands Section: zone	Auckland Unitary Plan: 'Best fit' zone	Comment	National Planning Standards: 'Best fit' zone	Comment
		The most closely related AUP zone is Open Space – Sport and Active Recreation Zone, which provides indoor and outdoor sport and active recreation and activities accessory to these activities.		
Open space 4 (marae)	Special Purpose – Māori Purpose Zone	The land unit provides for marae based activities and recognises and provides for the heritage, cultural, and community activities associated with a marae. The most closely related AUP zone is Special Purpose – Māori Purpose Zone, which has the purpose is to provide for the social and cultural needs of Mana Whenua and mataawaka and to promote the establishment of marae and papakāinga with supporting economic development to ensure thriving and self-sustaining Māori communities.	Special purpose zone: Māori purpose zone	The closest match in the National planning standard is the Māori purpose zone which has the definition: "Areas used predominantly for a range of activities that specifically meet Māori cultural needs including but not limited to residential and commercial activities"
Conservation	Open Space – Conservation Zone	The HGI land unit covers a number of smaller islands, both publicly and privately owned which have high scenic and ecological conservation values. The objectives and policies ensure that "the land unit is appropriately managed to enable conservation, preservation and enhancement of the natural environment along with appropriate educational, visitor and recreational activities". In the AUP, Open Space – Conservation Zone best fits the HGI land unit as it applies to open spaces with natural, ecological, landscape, and cultural and historic heritage values. The objectives and policies of the zone are "values of the zone are enhanced and protected from adverse effects of use and development" and "that use and development complements and protects the conservation values and natural qualities of the zone".	Natural open space zone	The closest match in the National planning standard is the Natural open space zone which has the definition: "Areas where the natural environment is retained and activities, buildings and other structures are compatible with the characteristics of the zone."
Tryphena settlement area		The HGI settlement is described as the largest existing population on Great Barrier and is characterised by a historical small lot pattern with small scale development, larger bush cover lots, the main wharf entry point for the island and two separate retail areas. The objectives and policies allow for		

Hauraki Gulf Islands Section: zone	Auckland Unitary Plan: 'Best fit' zone	Comment	National Planning Standards: 'Best fit' zone	Comment
		development in a way that doesn't compromise bush cover and limits the foot prints of buildings on larger sites.		
Tryphena (local retailing area)	Business – Neighbourhood Centre Zone	The objectives and policies of this area is to concentrate good quality visitor and local retail development and activities within the local retailing area. The minimum subdivision size is 1500m^2. The most closely related AUP zone is Business - Neighbourhood Centre Zone which applies to single corner stores or small blocks of shops which provide residents and passers-by with daily retail and commercial service needs. The objectives and policies refer to the zone as "attractive environments and attract ongoing investment, promote commercial activity, and provide employment, housing and goods and services".	Neighbourhood centre zone	The closest match in the National planning standard is the Neighbourhood centre zone which has the definition: "Areas used predominantly for small-scale commercial and community activities that service the needs of the immediate residential neighbourhood."
Tryphena (headland protection area)	Residential - Large Lot Zone	The objective of the area is to retain the high amenity value of the headland protection area as a means of separating the Mulberry Grove and Gooseberry Flat residential area. A small number of residential activities are permitted in the area. The minimum subdivision size is 3000m^2 (but on average is 7000m^2). The closest related AUP zone is Residential - Large Lot which objectives and policies refer to development maintaining the area's "spacious landscape character, landscape qualities and natural features". The minimum size of subdivision is 4000m^2.	Large lot residential zone	The closest match in the National planning standard is Large lot residential zone which has the definition: "Areas used predominantly for residential activities and buildings such as detached houses on lots larger than those of the Low density residential and General residential zones, and where there are particular landscape characteristics, physical limitations or other constraints to more intensive development"
Tryphena (residential amenity area)	Residential - Rural and Coastal Settlement Zone	The objectives and policies allow for development in a way that doesn't compromise bush cover and limits the footprints of buildings on larger sites. The minimum subdivision size is 2000m^2. In the AUP the most closely related zone is Residential - Rural and Coastal Settlement zone as the objectives and policies of this zone refer to a rural and coastal character. The minimum site size for subdivision is 2,500m^2.	Settlement zone	The closest match in the National planning standard is the Settlement zone which has the following definition: "Areas used predominantly for a cluster of residential, commercial, light industrial and/or community activities that are located in rural areas or coastal environments".

Hauraki Gulf Islands Section: zone	Auckland Unitary Plan: 'Best fit' zone	Comment	National Planning Standards: 'Best fit' zone	Comment
Tryphena (Mulberry Grove School area)	Special Purpose - School Zone	This HGI area provides specifically for the school and its associated activities. Subdivision is a non-complying activity. In the AUP the most closely related zone is Special Purpose - School Zone, which provides specifically for schooling activities.		No Special Purpose zone provided in the National Planning standard for schools
Medlands settlement area		Medlands settlement area is described as the second largest residential area on Great Barrier with the settlement running parallel to the Medlands beach including residential and visitor activities.		
Medlands (residential amenity area)	Residential - Rural and Coastal Settlement Zone	The objectives and policies talk about recognising the existing development and subdivision patterns and protecting the sensitive nature of the coastal environment. The minimum subdivision size is 2000m^2. In the AUP the most closely related zone is Residential - Rural and Coastal Settlement zone as the objectives and policies of this zone refer to a rural and coastal character. The minimum site size for subdivision is 2,500m^2.	Settlement zone	The closest match in the National planning standard is the Settlement zone which has the following definition: "Areas used predominantly for a cluster of residential, commercial, light industrial and/or community activities that are located in rural areas or coastal environments".
Medlands (dune and wetland conservation areas)	Open Space – Conservation Zone	The area is made up of coastal dune and wetland areas which remains in its natural state. The area allows for conservation activities, visitor information centre and one dwelling per site as a permitted activity. Subdivision is a non-complying activity and so no minimum size is specified. In the AUP, Open Space – Conservation Zone best fits the HGI land unit as it applies to open spaces with natural, ecological, landscape, and cultural and historic heritage values. The objectives and policies of the zone are "values of the zone are enhanced and protected from adverse effects of use and development" and "that use and development complements and protects the conservation values and natural qualities of the zone".	Natural open space zone	The closest match in the National planning standard is the Natural open space zone which has the definition: "Areas where the natural environment is retained and activities, buildings and other structures are compatible with the characteristics of the zone."
Claris settlement area		This HGI settlement is defined as mixture of wetlands, rolling dunes and flat alluvial pasture, it also has a mixture of uses including and airport, light industry, retail and residential. The objectives and policies state "to consolidate similar activities in		

Hauraki Gulf Islands Section: zone	Auckland Unitary Plan: 'Best fit' zone	Comment	National Planning Standards: 'Best fit' zone	Comment
		the areas identified to ensure that effects of activities do not affect the function of the airport and surrounding activities"..		
Claris (local retailing area)	Business - Neighbourhood Centre Zone	The objective of the retail area is "to facilitate the establishment of local retail, service and visitor activities of high amenity in the local retailing area, without compromising the function of Claris airport". The minimum subdivision size is 1500m^2. The most closely related AUP zone is Business - Neighbourhood Centre Zone which applies to single corner stores or small blocks of shops which provide residents and passers-by with daily retail and commercial service needs. The objectives and policies refer to the zone as "attractive environments and attract ongoing investment, promote commercial activity, and provide employment, housing and goods and services".	Neighbourhood centre zone	The closest match in the National planning standard is the Neighbourhood centre zone which has the definition: "Areas used predominantly for small-scale commercial and community activities that service the needs of the immediate residential neighbourhood."
Claris (residential amenity area)	Residential - Rural and Coastal Settlement Zone	The minimum subdivision size is 1500m^2. This closest related AUP zones is the Residential - Rural and Coastal Settlement zone as the objectives and policies of this zone refer to a "rural and coastal character" and have a minimum site size for subdivision of 2,500m^2.	Settlement zone	The closest match in the National planning standard is the Settlement zone which has the following definition: "Areas used predominantly for a cluster of residential, commercial, light industrial and/or community activities that are located in rural areas or coastal environments".
Claris (airport)	Special Purpose - Airports and Airfields Zone	The airport provides the main air transport link to the island and limits the activities to those which are associated with the functions of the airport. Subdivision is a non-complying activity. The closest relation in the AUP is the Special Purpose - Airports and Airfields Zone, which provides specifically for this activity.	Special purpose zone: Airport zone	The closest match in the National planning standard is the Neighbourhood centre zone which has the definition: "Areas used predominantly for the operation and development of airports and other aerodromes as well as operational areas and facilities, administrative, commercial and industrial activities associated with airports and other aerodromes."

Hauraki Gulf Islands Section: zone	Auckland Unitary Plan: 'Best fit' zone	Comment	National Planning Standards: 'Best fit' zone	Comment
Claris (dune and wetland conservation area)	Open Space – Conservation Zone	The area is made up of coastal dune and wetland areas in both a natural and modified state. The area allows for conservation activities, visitor information centre and one dwelling per site as a permitted activity. The minimum subdivision size is 1ha. In the AUP, Open Space – Conservation Zone best fits the HGI land unit as it applies to open spaces with natural, ecological, landscape, and cultural and historic heritage values. The objectives and policies of the zone are "values of the zone are enhanced and protected from adverse effects of use and development" and "that use and development complements and protects the conservation values and natural qualities of the zone".	Natural open space zone	The closest match in the National planning standard is the Natural open space zone which has the definition: "Areas where the natural environment is retained and activities, buildings and other structures are compatible with the characteristics of the zone."
Claris (light industry area)	Business - Light Industry Zone	The light industrial area provides for light industrial activities, while safeguarding against adverse effects to the surround environment. The minimum subdivision size is 2000m^2. The most closely related AUP zone would be the Business – Light Industry Zone, this is provides for industrial activities which no not generate odour, dust or noise.	Light industrial zone	The closest match in the National planning standard is the Light industrial zone which has the definition: "Areas used predominantly for a range of industrial activities, and associated activities, with adverse effects (such as noise, odour, dust, fumes and smoke) that are reasonable to residential activities sensitive to these effects"
Okupu settlement area **Okupu (residential amenity area)**	Residential - Rural and Coastal Settlement Zone	This settlement is characterised by sloping typology and dominance of regenerating vegetation. The objectives and policies enable development in a way that does not compromise the bush, ecological and landscape values. The minimum subdivision size is 2000m^2. In the AUP the most closely related zone is Residential - Rural and Coastal Settlement zone as the objectives and policies of this zone refer to a rural and coastal character. The minimum site size for subdivision is 2,500m^2.	Settlement zone	The closest match in the National planning standard is the Settlement zone which has the following definition: "Areas used predominantly for a cluster of residential, commercial, light industrial and/or community activities that are located in rural areas or coastal environments".
Whangaparapara settlement area	Residential - Rural and	Whangaparapara settlement is comprised mainly of residential activities and a wharf. The objectives and policies are to	Settlement zone	The closest match in the National planning standard is the Settlement

Hauraki Gulf Islands Section: zone	Auckland Unitary Plan: 'Best fit' zone	Comment	National Planning Standards: 'Best fit' zone	Comment
Whangaparapara (residential amenity area)	Coastal Settlement Zone	maintain the high value nature charataer of the wider area. The minimum subdivision size is 2000m^2. In the AUP the most closely related zone is Residential - Rural and Coastal Settlement zone as the objectives and policies of this zone refer to a rural and coastal character. The minimum site size for subdivision is 2,500m^2.		zone which has the following definition: "Areas used predominantly for a cluster of residential, commercial, light industrial and/or community activities that are located in rural areas or coastal environments".
Awana settlement area **Awana (residential amenity area)**	Residential - Rural and Coastal Settlement Zone	This settlement area is located at the southern end of a white sand bay and is characterised by well integrated housing that is set amongst the regenerating indigenous vegetation. The objectives and policies are to set to maintain and enhance the low impact character of the residential area. The minimum subdivision size is 2000m^2. In the AUP the most closely related zone is Residential - Rural and Coastal Settlement zone as the objectives and policies of this zone refer to a rural and coastal character. The minimum site size for subdivision is 2,500m^2.	Settlement zone	The closest match in the National planning standard is the Settlement zone which has the following definition: "Areas used predominantly for a cluster of residential, commercial, light industrial and/or community activities that are located in rural areas or coastal environments".
Okiwi settlement area		The HGI settlement has a primary school, sports fields and small collection of house, along with an area of rolling pasture. The objectives and policies provide for residential development and supports small scale commercial and education facilities.		
Okiwi (local retailing area)	Business - Neighbourhood Centre Zone	The objective of the retail area is "to provide an area for commercial activities which are compatible with the character and scale of Okiwi, to service the north part of Great Barrier". The minimum site size for subdivision is 1500m^2. The most closely related AUP zone is Business - Neighbourhood Centre Zone which applies to single corner stores or small blocks of shops which provide residents and passers-by with daily retail and commercial service needs. The objectives and policies refer to the zone as "attractive environments and attract ongoing investment, promote commercial activity, and provide employment, housing and goods and services".	Neighbourhood centre zone	The closest match in the National planning standard is the Neighbourhood centre zone which has the definition: "Areas used predominantly for small-scale commercial and community activities that service the needs of the immediate residential neighbourhood."

Hauraki Gulf Islands Section: zone	Auckland Unitary Plan: 'Best fit' zone	Comment	National Planning Standards: 'Best fit' zone	Comment
Okiwi (residential amenity area)	Residential - Rural and Coastal Settlement Zone	The objective of the residential area is " to maintain and enhance the low impact character of the residential amenity area". The minimum site size for subdivision is 2000m^2 . In the AUP the most closely related zone is Residential - Rural and Coastal Settlement zone as the objectives and policies of this zone refer to a rural and coastal character. The minimum site size for subdivision is 2,500m^2.	Settlement zone	The closest match in the National planning standard is the Settlement zone which has the following definition: "Areas used predominantly for a cluster of residential, commercial, light industrial and/or community activities that are located in rural areas or coastal environments".
Okiwi (Okiwi school area)	Special Purpose - School Zone	This HGI area provides specifically for the school and its associated activities. Subdivision is a non-complying activity. In the AUP the most closely related zone is Special Purpose - School Zone, which provides specifically for schooling activities.		No Special Purpose zone provided in the National Planning standard for schools
Port Fitzroy settlement area		This settlement is characterised small scale residential development adjoining a small bay. The objectives and policies are to maintain the existing development pattern and protect the bush coverage.		
Port Fitzroy (residential amenity area)	Residential - Large Lot Zone	The objective of this area is to protect and enhance the low impact bush covered character of the residential area. The minimum site size for subdivision is 5000m^2. In the AUP the most closely related zone is Residential - Large Lot which objectives and policies refer to development maintaining the area's "spacious landscape character, landscape qualities and natural features". The minimum size of subdivision is 4000m^2.	Large lot residential zone	The closest match in the National planning standard is Large lot residential zone which has the definition: "Areas used predominantly for residential activities and buildings such as detached houses on lots larger than those of the Low density residential and General residential zones, and where there are particular landscape characteristics, physical limitations or other constraints to more intensive development"
Port Fitzroy (local retailing area)	Business - Neighbourhood Centre Zone	This area provides retail activities which are compatible with the Port fitzroy area. The minimum site size for subdivision is 1500m^2. The most closely related AUP zone is Business - Neighbourhood Centre Zone which applies to single corner	Neighbourhood centre zone	The closest match in the National planning standard is the Neighbourhood centre zone which has the definition: "Areas used predominantly for small-scale commercial and community activities

Hauraki Gulf Islands Section: zone	Auckland Unitary Plan: 'Best fit' zone	Comment	National Planning Standards: 'Best fit' zone	Comment
		stores or small blocks of shops which provide residents and passers-by with daily retail and commercial service needs. The objectives and policies refer to the zone as "attractive environments and attract ongoing investment, promote commercial activity, and provide employment, housing and goods and services".		that service the needs of the immediate residential neighbourhood."

Appendix 18

Auckland Centres Growth and Capacity: Situation and Outlook

1. Overview

This Paper summarises the research into Auckland's main centres, focusing on the CBD and Metropolitan Centres.

It focuses on the plan-enabled capacity for growth into the long term.

2. Potential Floorspace

RIMU has estimated the potential buildable capacity for all centres and business areas according to proposed Plan provisions. This is based on site dimensions and taking into account building height constraints. The primary output is the estimated buildable floorspace capacity at each height (storey) level for the centres.

ME have drawn from this assessment to estimate the potential split between business floorspace and residential floorspace (apartments) allowing for assumed capacity. This allows for variation among centre types in terms of the business : residential split at each level, with business activity commanding most of the lower floors (Levels 1 to 5), but residential having a somewhat greater share from levels 6 and higher, to take advantage of views, and recognising the likely low incidence of retail and household service activity above the second level.

Initially, the estimates allow for variation among centre types (eg CBD vs Metropolitan Centres) but no variation within centre types. To illustrate, Takapuna can be expected to have a continuing strong demand for apartment space because of the relatively high natural amenity, which could see a higher proportion of its built space taken up for residential.

The estimates are shown in Table 1.

3. Floorspace Demand for Centres

For the enabled floorspace capacity itself, a key issue is whether the CBD and the Metropolitan centres (and other centres) are likely to have sufficient capacity to accommodate for business growth as well as residential growth.

To assess this, we have examined the current situation in these larger centres, and the growth outlook, taking into account employment, floorspace demand for business activity, and future employment trends. The assessment covers:

a. Current employment levels, using the Business Frame dataset for 2021 (the latest available from Statistics NZ). The assessment is by sector, to show the demand for space from each type of activity. For this overview, it is sufficient to examine total employment across all sectors of the economy.

b. The recent trends, focussing on employment growth by sector across the centres network, and other business areas.

Table 1 : Enabled Floorspace Capacity (000m^2) for CBD and Metropolitan Centres

	Levels 1-2	Levels 3-5	Levels 6-10	Levels 11+	Total	Levels 1-2	Levels 3-5	Levels 6-10	Levels 11+	Total
Total Space Enabled (000)						***Estimated Business Space Enabled (000)***				
City Centre	4,780	6,910	4,860	13,150	29,700	4,540	6,010	3,880	6,580	21,010
Albany	1,770	2,590	3,030	5,250	12,640	1,590	1,990	2,120	2,100	7,800
Botany	2,850	4,060	1,260	1,990	10,160	2,570	3,130	880	790	7,370
Henderson	1,340	1,980	1,800	2,390	7,510	1,200	1,520	1,260	960	4,940
Manukau	3,170	4,360	2,950	4,500	14,980	2,850	3,360	2,060	1,800	10,070
New Lynn	1,550	2,250	1,750	2,450	8,000	1,400	1,730	1,220	980	5,330
Newmarket	900	1,280	1,130	270	3,580	810	980	790	110	2,690
Papakura	570	810	720	70	2,170	520	630	510	30	1,690
Sylvia Park	780	1,120	1,070	1,830	4,800	700	860	750	730	3,040
Takapuna	430	630	720	740	2,520	390	490	510	290	1,680
Westgate / Massey	2,210	3,090	1,180	1,800	8,280	1,990	2,380	820	720	5,910
Estimated Residential Space Enabled (000)						***Estimated Residential Share %***				
City Centre	240	910	970	6,580	8,700	5%	13%	20%	50%	29%
Albany	180	600	910	3,150	4,840	10%	23%	30%	60%	38%
Botany	290	940	380	1,190	2,800	10%	23%	30%	60%	28%
Henderson	130	460	540	1,440	2,570	10%	23%	30%	60%	34%
Manukau	320	990	880	2,700	4,890	10%	23%	30%	60%	33%
New Lynn	160	520	520	1,470	2,670	10%	23%	30%	60%	33%
Newmarket	90	290	340	160	880	10%	23%	30%	59%	25%
Papakura	60	190	220	40	510	11%	23%	31%	57%	24%
Sylvia Park	80	260	320	1,100	1,760	10%	23%	30%	60%	37%
Takapuna	40	150	220	440	850	9%	24%	31%	59%	34%
Westgate / Massey	220	710	350	1,080	2,360	10%	23%	30%	60%	29%

c. The analysis also considers the property estate in terms of built investment and total capital value, and the estimated floorspace in commercial, other business and industrial activity based on Council's rating database (2021). A key indicator is the current level of floorspace per person employed (M^2/MEC) in each centre (Modified Employment Count). Table 2 summarises the current situation[1].

[1] Note that there is considerable detail available, for business activity, the land base, and the built property estate by main sector in each centre, for commercial, business and industrial land, as well as community facilities, health and so on. That detail is not need3ed for this overview.

Table 2 : CBD and Metropolitan Centres – Key Parameters 2021

Centre	Employment 2021	Total Improvement Value 2021	Total Capital Value 2021	Total Floorspace 2021	M2 / MEC
		($M)	*($M)*	*(000)*	
City Centre	123,900	22,700	40,000	4,895	40
Albany	7,800	1,100	2,400	286	36
Botany	8,900	800	2,400	527	59
Henderson	5,300	700	1,700	371	69
Manukau	14,700	1,400	3,400	693	47
New Lynn	5,900	800	1,900	456	77
Newmarket	18,700	2,600	5,400	536	29
Papakura	2,800	300	700	192	68
Sylvia Park	4,400	1,000	1,500	190	44
Takapuna	8,300	1,300	3,000	324	39
Westgate / Massey	3,200	700	1,900	229	72

4. Future Outlook for Floorspace Demand for Centres

The assessment has then covered the projected future employment levels in the centres. This has been modelled out to 2050. The modelling is based on first the projected total employment future by sector for Auckland over the 2021-2050 period. The projected numbers for each centre, and other locations across the Auckland spatial economy, have then been estimated based on their projected share of total employment growth from 2021 onwards, according to their current share of total employment, their share of employment growth by sector over the recent medium term (2010-2020), and the projected household growth in each centre's main catchment area.

Analysis of recent (medium term) employment growth across centres and business areas over the 2006-21 and 2010-21 periods showed clear influence of both the established level of employment at the start of any period, and the household growth in centres' service catchments over the period[2]. This is to be expected, given that Auckland is an established and stable economy, with a well-developed network of centres in the spatial hierarchy. Auckland's growth is occurring through the combination of outward expansion, and residential intensification, with much of the growth in household demand able to be served by established centres, with consequent increases in their employment levels, and addition of built investment for both business activity and residential capacity. That said, the employment projections are treated as estimates only.

The projected employment for each location and centre has considered the long term, out to 2050. The implied demand for floorspace has been estimated according to employment, the current employment intensity (floorspace m2 per MEC) with allowance for floorspace productivity to improve over time. This is expected to see the floorspace per person employed decrease.

The projected employment and estimated floorspace demand is set out in Table 3. This is for the Medium growth future.

[2] Showing out as high levels of 'explanation' (R^2) in statistical terms.

The table also shows the modelled floorspace capacity (Table 1) for the main centres, and the indicated uptake of the plan-enabled capacity by 2050.

Table 3 : CBD and Metropolitan Centres – Key Parameters and Demand Outlook (2050)

Centre	Employment 2021	Total Improvement Value 2021	Total Capital Value 2021	Total Floorspace 2021	M2 / MEC	Employment 2050-Medium	Estd Floorspace Demand 2050	Modelled Floorspace Capacity	Space Utiltn %
		$M	*$M*	*(000)*			*(000)*	*(000)*	
City Centre	123,900	22,700	40,000	4,895	40	273,200	10,040	20,949	48%
Albany	7,800	1,100	2,400	286	36	15,800	535	7,924	7%
Botany	8,900	800	2,400	527	59	17,600	967	7,898	12%
Henderson	5,300	700	1,700	371	69	11,000	711	5,128	14%
Manukau	14,700	1,400	3,400	693	47	29,300	1,282	10,345	12%
New Lynn	5,900	800	1,900	456	77	11,700	843	5,607	15%
Newmarket	18,700	2,600	5,400	536	29	39,500	1,053	2,574	41%
Papakura	2,800	300	700	192	68	6,100	380	1,658	23%
Sylvia Park	4,400	1,000	1,500	190	44	8,900	361	3,051	12%
Takapuna	8,300	1,300	3,000	324	39	17,500	638	1,662	38%
Westgate / Massey	3,200	700	1,900	229	72	6,500	436	6,386	7%

The key finding is that all the Metropolitan centres, as well as the central city, would have considerable capacity to accommodate long term employment growth.

5. Residential

The Metropolitan centres as well as the CBD have considerable potential to accommodate residential growth into the long term. This is expected to be almost entirely in the form of apartments developments, through a combination of mixed-use developments (business activity mainly on lower floors, apartments at higher levels (6 and above), and residential only developments (especially toward the edge of the centres).

Under the AUP, the Metropolitan centres have attracted a substantial share of new apartment development, accounting for around 4,180 new apartments (18% of the Auckland total) since 2016. The CBD has still been the centre of this growth (7,600 apartments, 32% share), supported by developments in the inner suburbs (1,170 apartments, 5%). Among the Metropolitan centres, Takapuna, Albany, Henderson and Newmarket have seen the largest shares of growth. One feature is that apartment development is also attracted to locations near the Metropolitan centres.

With the greater enablement in walkable catchments, and the increasing propensity of households to opt for apartment living (especially prior to and following raising families) this trend is expected to continue into the longer term.

All of the Metropolitan centres have substantial development capacity for apartment and mixed use developments.

6. Caveat

This assessment is necessarily based on projections into the long term future, with uncertainty about the economic future to start, and the future employment patterns – for example, the Covid-19

pandemic has seen a considerable shift toward working from home, with consequent reduction in demand for built employment space. Whether or not that shift persists into the long term is unknown. Certainly, the key property and space parameters of the centres reflect mainly the pre-Covid economy.

Nevertheless, the big picture for Auckland shows very considerable capacity to accommodate business growth in the CBD and Metropolitan centres, with large margins between the indicated plan-enabled capacity and the estimated demand, even in the long term.

That suggests considerable leeway, to conclude that capacity constraints are unlikely for any of Auckland's Metropolitan centres or the CBD.

Douglas Fairgray

12 August 2022

Appendix 19

Potential implications of larger walkable catchment extents

The Implications of Increasing the extent of 'Walkable Catchments'

Situation

There have been a number of suggestions that provisions to enable housing intensification should be applied across larger areas of Auckland, in order to increase the numbers of walking trips by residents.

To assess this, ME have considered:

a. Peoples' propensity to walk by trip distance. This is to take into account that propensity to walk decreases as trip distance increases (people are more willing to walk short distances than longer distances);
b. The level of demand for additional housing capacity, and whether increasing the size of intensification areas would result in more growth, or just a re-distribution of that growth;
c. From this, the expected total incidence of walking trips, allowing for different patterns of intensification around centres. This is the indicator of Catchment Walkability.

First, walkability is determined by distance. This means the walkability of any catchment derives from the number of people in that catchment, at each distance from the centre, with their mean number of walking trips determined mainly by that distance. Simply, if a catchment population is relatively concentrated near to a centre, then their number of walking trips will be greater than if the same population was distributed *pro rata* across the catchment.

As a consequence, increasing the diameter of an intensification area will not increase peoples' propensity to walk unless that also means that catchment attracts a larger share of the population. Otherwise, if it is just the same amount of housing growth and it is spread more widely, then overall walkability will be less, because a greater share of the population will live further from a centre. The mean number of walking trips per household can be expected to be lower than if intensification is more focused around the centre. On this basis, a Walkable Catchment of 400m radius can be expected to generate more walking trips *per capita* than a radius of 800m, and a radius of 800m to generate more *per capita* than a radius of 1,200m.

Second, the number of trips attracted to a centre – for employment, shopping, services or other purposes – is positively related to the size of the centre and the range of activity there. A large multi-faceted centre will attract more visits – by any mode – than a small centre offering fewer services. A larger centre also offers greater potential for people to make multi-purpose visits. One effect of this is that people can be expected to walk further for a multi-purpose visit than for a single-purpose visit – simply, the required walking effort per benefit acquired is less for a multi-purpose visit. One important implication is that a CBD or very large centre would have a broader walkable catchment than a smaller centre or node.

Third, a key matter is that the amount of plan-enabled capacity for housing is far greater than the anticipated demand for housing into the long term. This means that enabling intensification across wider areas around centres will not be expected to increase the total amount of housing development. Rather, increasing the opportunity to intensify will mean that same or similar amount of growth will occur over a wider area.

Analysis

ME have examined the potential to provide more plan-enabled housing capacity in an already urbanised area around a centre. This has been done on the Auckland central isthmus, in order

to cover an area which can be circular in shape, and not impacted by coastline, maunga, or other irregularities. We note that the results are not sensitive to the example, as the distance and plan enablement are similar to other parts of urban Auckland.

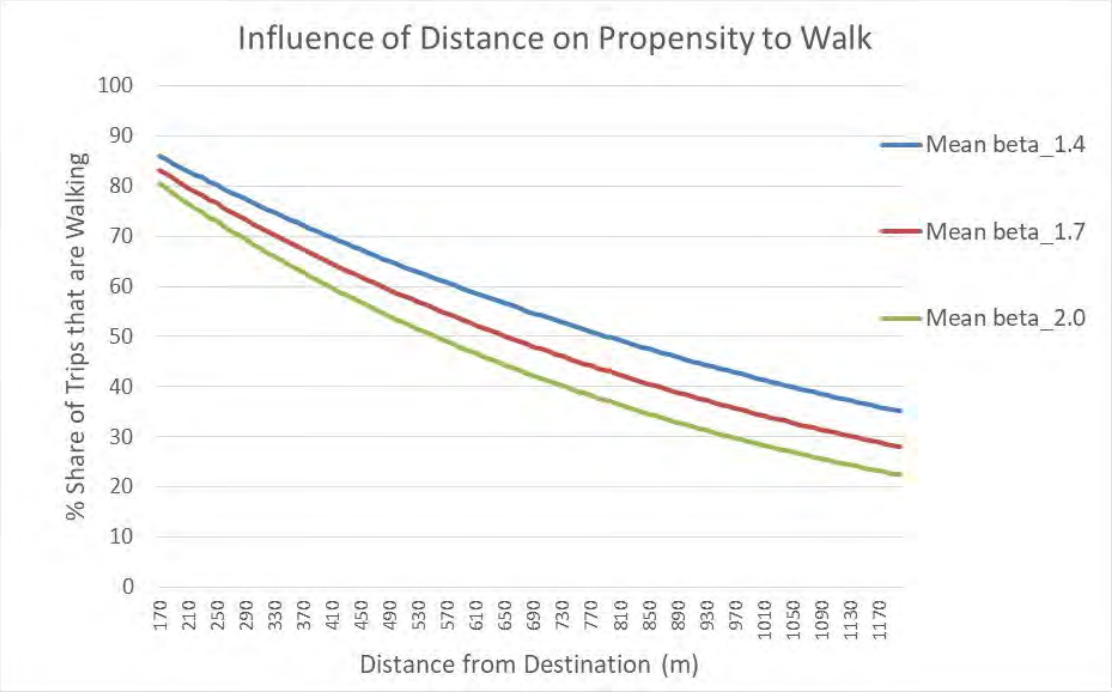
The analysis simply tests the likely propensity to walk of a given resident population – existing and growth – under different intensification outcomes. In each case, the resident population and household count is assumed to double. The intensification outcomes are as follows:

1. Outcome 1 - Growth is spread *pro rata* across the 1,200m Walkable Catchment
2. Outcome 2 - The same amount of growth is concentrated into the closest 800m distance band around the centre
3. Outcome 3 - The same amount of growth is concentrated into the closest 400m distance band around the centre

In all cases, there is plenty of plan-enabled capacity to accommodate the growth, so that the only matter being compared is the distribution of that housing, and the consequences for the number of walking trips. The growth outcomes were examined to estimate the numbers of dwellings within each 10m distance band around the centre and estimate propensity to walk on that basis.

The propensity to walk for trips of each distance was estimated from research into walking purpose by demographics in the United States[1]. For walking journeys in urban environments, the research found general *beta* coefficients of 1.7 for work trips, 1.27 for recreational trips, and 1.96 for shopping and social trips. We utilised the 1.7 coefficient as the mean value and beta values of 2.0 and 1.4 as simplified upper and lower bounds. These patterns are shown in Figure 1.

Figure 1 – Influence of Trip Distance on Propensity to Walk



[1] Yang, Y., & Diez-Roux, A. V. (2012). Walking distance by trip purpose and population subgroups. *American journal of preventive medicine*, *43*(1), 11-19.

As the final step, assuming a constant level of trip-making per household, the number of walking trips was estimated according to these propensities.

Findings

The main finding is that increasing the size of Walkable Catchments – intensification areas – around centres is very unlikely to increase catchment walkability.

Figure 2 summarises the results. Key findings are based on comparing catchment walkability (mean trips per household) within a 1200 m radius, under different growth outcomes. In each case, the existing population base is assumed to stay the same, with only growth distributed differently.

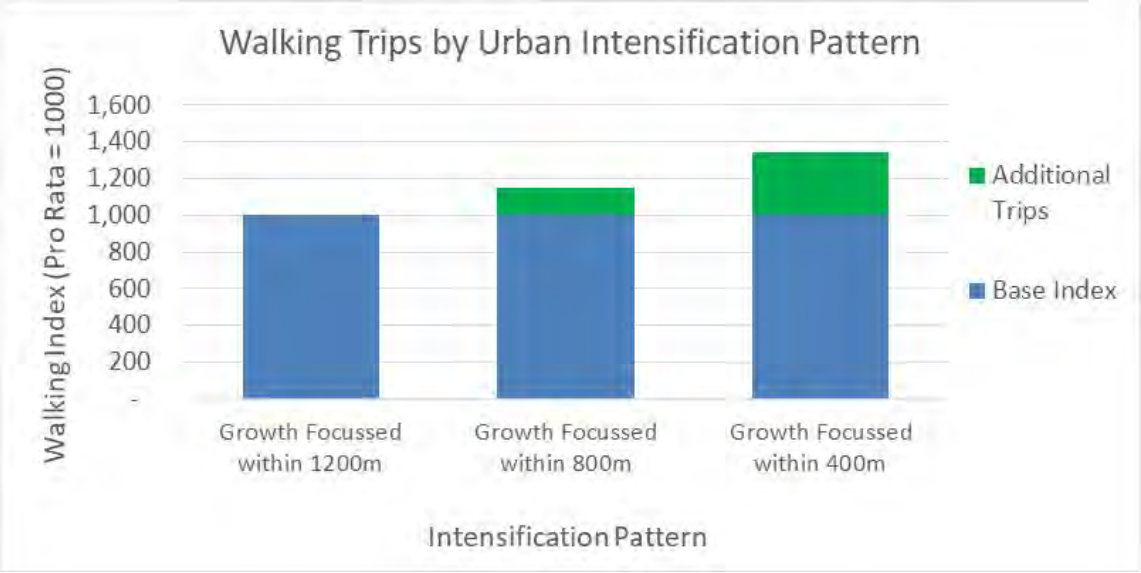
Catchment walkability is estimated for the total population – existing and growth – in each case.

The analysis shows:

a. Assuming the same level of intensification within 800m as would otherwise occur within 1200m, the mean propensity to walk (per household) would be 17-18% higher than if the same growth were distributed *pro rata*.

b. If the same level of intensification occurred within 400m, then mean propensity to walk (per household) would be 39-41% higher than if the growth occurred *pro rata* across the 1,200m catchment.

Figure 2 – Influence of Urban Intensification Patterns on Walking Trips



Importantly, the analysis examined the same number of households in each case, just with different patterns of intensification. The results indicate that focusing intensification more closely around centres will result in greater levels of walking trips, in the range of 17-40%.

This finding is fully expected, given that peoples' propensity to walk is directly affected by trip distance.

One implication is that increasing the radius of a notional 'Walkable Catchment' is likely to be counter-productive in terms of the amount of walking undertaken by the community if that means the same overall housing intensification is simply distributed more widely.

The same pattern is evident for larger catchments, for example a 1200m walkable catchment would indicate greater overall walkability than a 1,600m radius catchment. As noted, however, the overall number of trips made and walking trips made, is directly related to the size of the centre. On that basis, the walkable catchment for a CBD would be larger than for a centre lower in the centres hierarchy, and for catchments for transport nodes.

Douglas Fairgray

8 August 2022.

Appendix 20

Summary of literature on walkable catchments

Overview of the reviewed literature on walkable catchments

This appendix sets out short summaries that give an overview of the reviewed literature on walkable catchments. Part 1 focuses on walking in relation to public transport while Part 2 focuses on walking in relation to centres (or more generically retail, work etc). There is of course overlap between the two parts as some literature covers both walking in relation to public transport and centres (as well as other destinations). The full references are included at the end of this Appendix.

Part 1: Walking in relation to public tranport

1. Active-transport walking behavior: destinations, durations, distances

(Millward et al., 2013) – Halifax, Canada

The authors analysed walking behaviour with a focus on active-transport (AT), as opposed to walking for leisure/recreation. AT walks were found to be moderately faster than recreational walking, and typically shorter in (i) time and (ii) duration.

The authors found that **the majority of AT walks by individuals were within 600m**. **Very few surpassed 1200m** (p. 108). This is referred to as a 'distance-decay' effect. A strong distance-decay relationship was found for *all* major destinations: *home, workplace, bus stop or ferry terminal, restaurant or bar, someone else's home, grocery store, retail, shopping centre or mall, outdoors away from home, bank, and school.* The median duration of AT walks was **six minutes** (p. 103).

Origins & destinations of walks:

Importantly, the authors note the diversity in origins and destinations of AT walks – not limited to only home and work. Nevertheless, they were the most common. The foremost origins/destinations were ranked: (p. 106)

1. Home
2. Workplace
3. **Bus stop or ferry terminal**

Purpose of walks:

In terms of AT walking purposes – travel-to-shop exceeded travel-to-work (p. 101, 107).

2. Case Study: Relationship of Walk Access Distance to Transit with Service, Travel, and Personal Characteristics

(Alshalalfah & Shalaby, 2007) – Toronto, Canada

The study examined the relationship of 'access walk distances' with: (i) personal characteristics *(socio-economic, demographic)* and (ii) transit-service characteristics *(household location, route frequency, etc.).*

In particular, the authors found that public transit (PT) users **will walk further distances for access to subway lines than to bus routes.** The median distance that users are willing to walk (for the two options) is estimated with a difference of 100m (p. 118).

At the time of the study, the Toronto Transit Commission (TTC) implemented a 300m distance for "defining the boundary of a transit route's service area" (p. 114). However, the study found that 86% of

transit users live **within 500m** of respective transit routes (p. 115), while only 69% live within 300m. This was interpreted to indicate transit users are willing to walk *further* distances than TTC originally hypothesized with a 300m transit-route service area.

Additionally, the study found **higher-frequency routes "attract more riders, and have larger catchment areas** than lower-frequency routes" (p. 118).

3. Distances people walk for transport

(Burke & Brown, 2007) – Brisbane, Australia

Individuals are willing to walk to various locations, but for limited distances. The study found the following distributions of walking distances overall: *(p. 16)*

Journey	**Median**	**85th percentile**
Walk from home to all other places	**780 m**	**1450 m**
Walk from home to all public transport stops	**600 m**	**1300 m**
Walk from public transport stops to end destinations	**470 m**	**1090 m**

As depicted in the table, individuals tend to walk longer distances for 'single-mode trips' (walks directly to destination) than for 'walk trip stages' (made to or from public transit). However, the study found that 'walk trip stages' (to/from PT) were over **double in frequency** compared to 'single-mode walk trips.'

The table above depicts the overall figures. A more detailed version is below:

Walk from home to other places: *(p. 21)*

Journey	**Median**	**85th percentile**
Home to shop	680 m	1240 m
Home to primary school	790 m	1340 m
Home to usual workplace	1004 m	1850 m

Walk from home to public transport stops: *(p. 22)*

Journey	**Median**	**85th percentile**
Home to bus stop	440 m	1070 m
Home to ferry terminal	890 m	1540 m
Home to train station	890 m	1570 m

Walk from public transport stops to end destinations*: (p. 23)*

Journey	**Median**	**85th percentile**
From bus stop to destination	330 m	850 m
From ferry terminal to destination	830 m	1280 m
From train station to destination	620 m	1320 m

4. Explaining walking distance to public transport: The dominance of public transport supply

(Daniels & Mulley, 2013) – Sydney, Australia

The *mode* of public transit walked to is the primary determinant of walking distance from home to public transit. PT by train was interpreted as preferrable over bus, indicated by walking choices made.

Overall, **individuals walked further from home to access train services**, compared to bus services. This is despite a much higher distribution of bus stops than train stations. The authors note that *"people have to walk farther to reach one of the 300 train stations than to reach one of the 35,000 bus stops"* (p. 14) – likely passing by a bus stop and intentionally forgoing it on the way.

Sydney's planning guidelines aim to ensure 90% of households live within a 400m distance to PT services (train or bus) during daytime. The authors believe their study supports other research findings that individuals will walk distances **exceeding 400m** to access PT, *if* they decide to walk.

5. Forecasting Transit Walk Accessibility: A Regression Model Alternative to the Buffer Method

(Zhao et al., 2003) – Southeast Florida

The study focuses on weaknesses of the 'GIS buffer method' typically used for calculating transit walk accessibility. It is often employed by councils, such as assuming a 0.25 mile (or 400m) buffer area as 'walkable'.

Though simple, this method does not account for natural or man-made barriers in the actual urban fabric (e.g. steep slopes, highways with insubstantial access, fences); and discounts their implications. Further, it assumes 'straight' walking lines, despite the crookedness of streets in reality – meaning actual walking distances are often underestimated.

The authors find that walking accessibility is overestimated when using the buffer method (as well as the network method). They propose using a 'regression model instead, for measuring accessibility.

The dependant variable = % of population in a zone served by transit.

Potential independent variables = include the following:

- number of households per acre in a zone
- number of residents per acre in a zone
- ratio of commercial employees to total zonal employees
- ratio of service employees to total zonal employees
- bus route density in feet per acre
- number of internal streets intersecting the boundary of a travel analysis zone.

The authors find that a regression model has higher predictive potential in measuring walk-accessibility (compared to the buffer method), as they can consider additional factors (including barriers & population distribution).

6. How Does Car Parking Availability and Public Transport Accessibility Influence Work-Related Travel Behaviors?

(Badland et al., 2010) – North Shore, Auckland

The study examined the travel behaviours & choices of NZ working adults.

Of the eligible participant pool that matched all study requirements *(in paid work, routinely travelled to work by public or private motorized transportation & had a single work destination)*, 12.1% were found to routinely commute to and/or from work via PT, for at least a portion of their travel.

In particular, proximity to PT stops and perceived accessibility were factors influencing PT choices.

Higher PT usage was observed in individuals who lived within 200m of a bus stop, and in those who viewed PT as accessible. In contrast, lower levels of usage were observed when on-site parking or a company car was available to the worker. The implication is that work-related travel choices are **strongly related to convenience and accessibility**, as interpreted by the authors.

7. How Far, By Which Route, and Why? A Spatial Analysis of Pedestrian Preference

(Agrawal et al., 2008) – Portland & San Francisco

The research employed a participant pool of 328 pedestrians, via a one-off survey. It found that **0.5 miles (~800m)** was the average distance individuals were willing to walk, to access a rail station.

The factor of **distance** was most significant to the individuals' choice of **walking route**. This was supported by the following survey findings:

- Participants were asked: *'What are the main reasons why you chose your route today'* with space for three answers. **52% listed the 'shortest or fastest route' *first,*** to justify their chosen route. This was also the most frequent answer by far; mentioned by almost two-thirds of all participants.

- Additionally, 9% of respondent mentioned 'convenience' – which the authors considered a similar expression.

- 82% of participants rated 'choosing the shortest route' as *very important*; a further 17% rated it *somewhat important*.

Additionally, this study found that the distances pedestrians will walk to train services may be further than previous studies report (e.g. O'Sullivan & Morrall, 1996). Previously, walkable distances were typically assumed at under 0.5 miles (~800m). **Here, half of respondents reported walking 'at least' 800m to their local train stations.**

The finding suggests that planners may consider further walking distances to train stations as feasible, compared to previous assumptions.

8. New evidence on walking distances to transit stops: Identifying redundancies and gaps using variable service areas

(El-Geneidy et al., 2014) – Montreal, Canada

Commonly, public transit agencies employ buffer zones of 400m around bus stops, and 800m around rail stations – to determine areas accessible by foot to PT services (p. 193). The study suggests that the status quo buffer distances "underestimate the effective service areas around transit stations" (p 208).

Through an analysis of 16,014 home-based transit trips, (established via Montreal's five-year Origin-Destination (OD) survey), the study found the following distributions of walking distances:

Journey from home to:	**85th percentile:**
Bus stop	524 m
Rail station	1259 m

Evidently, the 85th percentile of *walks from home to transit stations* is **greater** than the general rule of thumb (400m & 800m respectively). The findings support a revision of the status quo.

Additionally, the study finds that individuals are willing to walk further distances for routes which provide a **shorter wait time** (p. 208).

9. Improving the cost-benefit analysis of integrated PT, walking and cycling

(Wedderburn, 2013) – NZ

This report (90 pages) is based on walking, cycling and public transit. It evaluates factors which may impact and/or enhance the prevalence levels of these travel modes.

In terms of walking, the report drew on research by Ministry of Transport's *NZ Household Travel Survey*, which **indicated lower walking distances** to and from PT services in NZ, when compared to international findings (p. 9, 35).

The median distance of walks to *bus services* was 200m; and 75% of these trips under 500m (p. 35). This is lower than the typical 400-800m distances reported internationally.

However, figures for walks to ***rail services*** were notably higher; and aligned closer to international examples. The median distance walked for access to rail stations was over 1km (mean distance: 1.13km) – (p. 35).

These figures indicate that individuals are **willing to walk longer distances to faster PT modes** (such as rail or ferry services – to which further walking distances by individuals were observed, p. 9). This is consistent with existing findings in literature.

10. Walking Distances to and from Light-Rail Transit Stations

(O'Sullivan & Morrall, 1996) – Calgary, Canada

The study develops a quantifiable rationale for 'accessible' walking distances. It is based on the interview results of 1800 light-rail transit users during peak hours: for 23 out of 31 stations in Calgary.

It found the following results, for distances walked to transit stations:

Station	Average	75th percentile
Suburban stations	649 m	840 m
CBD stations	326 m	419 m

- Walking distances to local stations in suburban areas were **approximately double** that for central stations.

- In comparing the results to that of bus stops, the authors noted that **people generally walk much further to access a light-rail station**. Thus, a distinction in walking distance guidelines for each should be established.

It may be noted that the study utilized 'assumed walking paths' – derived from interview information of 'approximate origins.' The authors then transferred this info to a *1:4000 scale* map. The assumed path was the shortest sidewalk route that could be used to access the station. Some cases used shortcuts, such as through back alleys, for parts of the trip in lieu of the sidewalk alternative.

11. Rail Access Modes and Catchment Areas for the BART System

(Cervevo et al., 1995) – San Francisco

The paper examines the impact of the built environment on: (1) transit modes to & from train stations; and (2) the sizes and shapes of the ridership catchment areas.

It is based on the foundational assumption that lowered densities and increased distances to city centres correlate with increased reliance on *motorized travel*, in order to reach train stations.

The study found that **density has a substantive influence on the modal choice of individuals**, when accessing train stations. Land-use mixture was also found as influential, but to a lesser degree.

Overall, **more dense, mixed-use areas** saw higher proportions of walking-trips for train station access.

These areas also saw **acceptability of *further* walking distances**:

> (i) acceptable walking access (home-end) distances increases by 200-300 feet (~ 60-90 m) – p. 47.
>
> (ii) acceptable walking egress (work-end) distances increases by 200-600 feet (~ 60-180 m) – p. 47.

Evidently, people are willing to walk further at the egress/work-end, than the access/home-end. It indicates that people prefer walking from the station to work, rather than wait for a bus service, if they can do so within 5-10 mins (p. 48).

See table below (copied – p. 47) for detailed figures:

Table 17. Summary on Influence of Distance on Modes of Access and Egress Among Classes of BART Stations

Station Class	Distance up to which Walking Predominates: Home-End Access	Distance up to which Walking Predominates: Work-End Egress	Mode of Access Beyond Walking Distance: Dominant	Mode of Access Beyond Walking Distance: Secondary	Mode of Egress Beyond Walking Distance: Dominant	Mode of Egress Beyond Walking Distance: Secondary
San Francisco Office Center	3,000 ft.	4,000 ft.	Transit	—	Transit	—
San Francisco Commercial/ Civic Center	4,000 ft.	3,300 ft.	Transit	Kiss-n-ride	Transit	—
Downtown Oakland	3,800 ft.	3,600 ft.	Transit	Kiss-n-ride	Transit	—
Urban Drive-alone/ Districts	3,300 ft.	3,600 ft.	Transit	Kiss-n-ride	Transit	Bicycle
Suburban Centers	Park 2,700 ft.	Kiss-n-ride/ 3,300 ft.	n-Ride	Passenger Transit	Transit	Pick-up
Low-Density Areas	Park- 2,900 ft.	Transit/ 2,900 ft.	Passenger n-Ride	Kiss-n-ride	Transit	Pick-up

From this table, the mean walking distances are:

- 3283 ft **(1,001 m)** for access walks
- 3450 ft **(1,052 m)** for egress walks.

12. Impediments to Walking as a Mode Choice

(Walton & Sunseri, 2007) – NZ

This study is primarily concerned with 'park-and-ride' commuters who drive to PT stations, park their car, then ride the PT service. The study attempts to uncover why these commuters choose car usage, rather than walking to the station.

Research is conducted mainly through a survey measuring *attitudes to walking* of 'park-and-ride' commuters living within 1km of the station; compared to that of walkers to the station.

Notably, the study found that people perceive a **'reasonable' walking distance to be approximately 820m (p. 34); roughly 9-10 minutes in duration.** The majority of participants lived within this travel distance.

However, the authors interpret that: (i) convenience offered by the station's car parking facility & (ii) the availability of a private vehicle – are likely to evoke car usage by individuals **'who might *otherwise* walk 1 km to the station'** (p. 33). This comes down to a matter of preference, where the alternative (of park-and-ride) is simply perceived as better or more advantageous/convenient than walking.

Thus, the study encourages the disincentivization of 'park-and-ride' trips; to enhance choices made to walk. Mechanisms may include fee-paying parking or reductions in parking convenience.

13. Travel and the Built Environment

(Ewing & Cervero, 2010)

The authors employ a meta-analysis, examining existing studies on the urban environment and their impacts on transit modes. Influences were measured by the elasticity of various modes in response to different variables.

Interestingly, the study finds that 'density' itself is weakly associated with travel. The authors interpret this to suggest that "density is an intermediate variable that is *often expressed by the other D's*" (p. 276) – including short blocks, mixed usage, and central localities. (5 D's = Density, Diversity, Design, Destination accessibility, Distance to transit)

Results found that walking is mostly associated with:

- land use diversity
- intersection density
- the quantity of destinations within walking distance (p. 265).

In particular, **destination accessibility** had the largest influence on non-motorized travel such as walking (p. 276).

Also of note:

- *Jobs-housing balance* was more strongly correlated to walking than *land-use mix*
- *Population density* was more strongly correlated to walking than *job density*

14. Does Compact Development Make People Drive Less?

(Stevens, 2017)

Stevens (2017) finds through meta-regression analysis that compact development indeed makes people drive less – but *not by much*. As this influence is limited, he discourages planners from depending solely on compact development, as the mechanism for reducing private motorization.

Nevertheless, his results yielded a negative statistical correlation between driving and compact development features. Notable variables were ranked by their extent of influence on driving, in the following order from highest to lowest (p. 14) –

1. Distance to downtown
2. Population density
3. Job accessibility by auto
4. Intersection and street density
5. Land use mix
6. Job density

The most strongly-influential variable on driving was the *distance to downtown*. With every 1% decrease in distance from household to downtown, driving decreases by 0.63%.

People also drive moderately less in areas of **higher street-connectivity** (expressed through intersection & street density) – as **"feasibility and convenience of walking" transpires** (p. 14).

Note: Stevens also acknowledged that some discrepancies exist in the results of differing studies on compact development and driving. He considered three likely causes (p. 4):

1) Sampling errors
2) Differences in study controls – (some studies control for residential self-selection, some do not; leading to inconsistency).
3) Selective reporting – (which may skew results or lead to inconsistencies)

15. "Does Compact Development Make People Drive Less?" The Answer Is Yes.

(Ewing & Cervero, 2017)

This paper is a commentary on the previous article (above) by Stevens (2017). It compares his findings to the authors' own (reading no. 13.)

Here, the authors note that they are measuring essentially the same issue as Stevens (elasticies of *vehicle miles travelled* – VMT); yet the two studies come to different results, characterizations, and conclusions.

The main questions and issues raised are as follows:

- **Does Stevens draw appropriate conclusions from his findings?** The authors believe Stevens overreached in his conclusion that compact development has 'not much' influence on driving. They do not believe this is consistent with their findings, or his own (which found a negative statistical correlation).

- **Does Stevens appropriately categorize our results and his results?** The authors believe Stevens incorrectly categorized the results. They regard statistic 'inelasticity' to mean differently from a 'small' relationship – the latter term expressed by Stevens. In other words, inelasticity does not necessarily mean an influence is small; it is relative.

- **Does Stevens appropriately depict the costs & benefits associated with compact development?** While Stevens' article may suggest that reduced driving is the sole benefit of compact development, the authors believe there are extensive interests beyond that. They are unsatisfied with Stevens' singular and brief acknowledgement of further benefits.

- **Does Stevens appropriately categorize his meta-regression analysis as more rigorous than our meta-analysis?** The authors disagree with this depiction for various reasons; including that only 37 studies were included in Stevens' final sample.

16. Urban Densities and Transit: A Multi-dimensional Perspective

(Cervero & Guerra, 2011) – U.S.

The study examines the relationship between transit and urban densities, in cities across the U.S.

The main conclusions of the study were that light-rail and heavy-rail systems require the following densities, to be categorized as the top 25% of cost-effective rail investments: (p. 10)

- 30 people per gross acre around light-rail stations
- 45 people per gross acre around heavy-rail stations

Further, ridership increases would be significant particularly with job concentration within 0.25 miles (~400m) of a station, and housing concentration within 0.5 miles of a station (~800m).

As part of its analysis, the study addressed **station catchment areas**. The authors referenced the findings of O'Sullivan and Morrall (1996) that transit walking distances were suggested at 300-900m.

Their own findings, however, reported walking distance as 'largely irrelevant' to their method of *direct demand modelling*. Nevertheless, they note that the *most* appropriate models applied were the:

- 0.25 mile (~400m) radius for job counts
- 0.5 mile to 0.75 mile radii (~800 – 1200m) for population counts.

The authors interpret this as support for respectively employing a 0.25 mile catchment area for jobs, and a 0.5 mile catchment for population (p. 10).

17. Varying influences of the built environment on household travel in 15 diverse regions of the United States.

(Ewing et al., 2015) – U.S.

The study predicts 5 household travel outcomes (car trips, walk trips, bike trips, transit trips and vehicle miles travelled); using built environment variables. In terms of walk trips, the following factors are associated with **increased (walk-trip) likelihood** (p. 2340):

- Land use diversity – [within 0.25 mile of home]
- Intersection density – [within 0.5 mile of home]
- Activity density & percentage of 4-way intersections – [within 1 mile of home]
- Accessibility to employment – [within 30 minutes by transit]
- **Transit stop density** – [within 0.5 mile of home]
- Regional compactness

The authors note an interesting finding that: "walk trip frequency depends on the built environment *at a larger scale* than the usual one-quarter mile (~400m) walk distance assumed by planners" (p. 2341).

They suggest the **relevant environmental scale** to walk trips is roughly 0.5 to 1 mile (~ 800 to 1600 m).

- This is indicated by the U.S.'s *Nationwide Household Travel Survey*. It reports an average walk trip distance of 0.52 miles for shopping, and 0.88 miles for work; with an overall average of 0.70 miles.

18. Exploring built environment impacts on transit use – an updated meta-analysis.

(Aston, 2020)

This is a more recent meta-analysis of research; consisting of 418 data points, integrated from 89 published studies. It is an updated study from Ewing & Cervero's meta-analysis in 2010 *(no. 13)* and Stevens' meta-regression analysis in 2017 *(no. 14).*

Similarly, it considers the *impact of the built environment on transit usage.*

Elasticity of transit use was tested against 12 built environment factors. 3 factors were found insignificant to transit use: *activity density, population centrality, housing mix*. The remaining 9 variables had significant and positive impacts.

They were ranked, from highest to lowest, in elasticity impact on transit use (p. 85):

1. **Land use mix**
2. **Pedestrian connectivity**
3. **Jobs-housing balance**
4. Commercial density
5. Population density
6. Employment density

7. Safety
8. Local access
9. Amenity

The author's conclusion aligns with that of Stevens (2017); in that there is a "**small** but imprecise nature of the relationship between the built environment and transit use" (p. 92). However, the author also notes that various aspects of density, design, access, and diversity have notable contributions to public transit demands (p. 92).

19. Transit Capacity and Quality of Service Manual [Chapter 4]

(National Academies of Sciences, Engineering, and Medicine, 2013)

Transit services should be available within accessible walking distances from the origins and destinations of trips. Both ends of the trip must be considered – known as 'service coverage.'

The synthesized results of several 1960s-1980s studies indicate that:

- The majority of passengers (75-80%) walk up to 400m for bus services.
- Walking distances travelled to **rapid transit stations** are much further.
- Half (~50%) of passengers walk greater than 800m for RT services.

Other variables impacting walking distance or walkability include:

- Terrains: flatter land offers a more friendly pedestrian environment, while hilly routes require greater effort (or potentially stress) and are associated with shorter walking distances.
- Pedestrian safety: wide & busy streets deter pedestrians when there are inadequate crossing facilities.
- Street patterns: grid street layouts typically provide direct & easier access to transit services.
- Facilitation for disabled or diverse/universal needs.

20. Many Pathways from Land Use to Health: Associations between Neighborhood Walkability and Active Transportation, Body Mass Index, and Air Quality

(Frank et al., 2006) – Washington State

The study evaluates the relationship between walkability and health-related outcomes.

> Walkability was calculated by measures of: *land use mix, street connectivity, net residential density & retail floor ratios.*

Found: Those residing in more walkable neighbourhoods would walk more (and bike more), as modes of active transportation. Coincidentally, they also had lower BMI's, drove less, and contributed less air pollution than those residing in less walkable neighbourhoods.

A 5% increase in walkability was related to:

- 0.23-point decrease in BMI
- 6.5% decrease in vehicle miles travelled
- 5.6% decrease in nitrogen emitted; 5.5% decrease in volatile organic compounds emitted.

There was no relevant mention of attractive walking distances; only one vague reference of the mean distance to the nearest bus stop being 1/3 mile.

21. Contextualizing Walkability: Do Relationships Between Built Environments and Walking Vary by Socioeconomic Context?

(Adkins et al., 2017) – Review

There is generally consensus that supportive built environments are associated with higher levels of walking. This paper looks at whether the relationship varies when observed in different social groups: *the advantaged and disadvantaged.*

17 published articles were reviewed. It concluded that the relationship (between a supportive built environment for walking & higher walking rates) **was larger in advantaged groups** than in disadvantaged ones; by over two-fold. *Disadvantaged groups included: low-income and racial/ethnic minorities.*

In terms of **walking as active transport**, authors found that the 'built environment effect' produced the following:

- 70% more AT walking for disadvantaged groups
- 183% more AT walking for advantaged groups.

This conveys that the effect was **2.6 times stronger for advantaged groups** (p. 307).

The disparity is likely due to differing attributes of the *social* environment – wherein disadvantaged communities are more likely to experience fear of crime and lack of social support (p. 296, 310). The implication is that *"efforts by planners to further improve the built environment will likely not address underlying barriers to walking"* and may *"be at odds with more immediate community needs and priorities" (*p. 310). This represents a challenge to planners.

22. Pedestrian Access to Transit: Model of Walk Trips and Their Design and Urban Form Determinants Around Bay Area Rapid Transit Stations.

(Loutzenheiser, 1997) – San Francisco

Pedestrian access to the Bay Area Transit System (BART) is measured, through survey data from 34 BART stations. Nearly 34,000 responses were collected from the 13 suburban stations, 8 downtown stations & 13 urban-residential stations *(as of 1992).*

Notably, the results found that:

- Walking had –
  - A 23.7% mode share, for home-based access trips to BART stations.
  - Over 75% mode share, for home-based egress trips from BART stations.
  - The above figures are the overall. For individual stations, the walk access share varied from under 3% to 74%. This means there are numerous factors which influence the decision to walk.

- Distance is the most significant factor influencing the choice of walking.
  - Those living near a station were more likely to walk there.
  - **For every additional 0.5km from a station, the probability of walking is reduced by 50%** (p. 10).

- Retail is strong incentive for walking.
  - Retail-dominated stations were associated with high levels of walking (p. 8, 10).

23. Walkable catchments analysis at Auckland train and Northern Busway stations

(Wilson, 2013) – New Zealand

The study aims to elaborate on the findings from a 2010 survey by the (then) Auckland Regional Transport Authority. The 2010 survey found that the median walking distance to Papatoetoe train station was 1200m – further than the 800m radius typically assumed for walkable catchments.

In 2012, Auckland Council's surveys produced similar findings for New Lynn, Glenn Innes, and Mt Albert train stations. Notably, they found:

- Over 50% of respondents walked further than 800m to access train stations
- Over 15% of respondents walked further than 1500m to access train stations
- Walking is the most prevalent mode of travel for trips under 2000m in distance.

The 2013 study extended the research to a further 12 train stations[1] and 5 Northern Busway stations.[2] Again, the aim was to investigate **whether an 800m radius accurately represented the walking distance** of passengers to the respective stations. The results of the surveys were as follows:

For the 12 train stations:

- There was significant variation in **median walking distances** to each station.
- Papakura had the highest (971 m); followed by Panmure (917 m).
- Newmarket had the lowest (446 m); followed by Ellerslie (569 m).

- To reach the station:
- At four stations: over 50% of respondents walked further than 800m
- At six stations: over 15% of respondents walked further than 1500m

- Walking was the most common **form of arrival** at nine out of 12 stations.
- This was measured by percentage (%) of respondents who walked to the station.
- Ellerslie had the highest (73%); followed by Newmarket (69%)
- Manurewa had the lowest (42%)

For the 5 bus stations:

- There was even greater variation in **median walking distances** to each station.
- Albany had the highest (2727 m).
- Smales Farm had the lowest (588 m); followed by Akoranga (590 m).

- To reach the station:
- At four of five stations, 50% of respondents **walked further than 800m**.
- The exception was Akoranga.

The 2013 study concluded that: The 800m catchment radius is representative of *some* stations, but for others, it is lower than the actual walking distance people are willing to walk. Evidently, there are cases where individuals will walk further than 800m to access train services.

[1] *Manurewa, Otahuhu. Panmure, Papakura, Newmarket, Henderson, Onehunga, Pukekohe, Glen Eden, Meadowbank, Sturges Road, Ellerslie.*

[2] *Albany, Constellation, Sunnynook, Smales Farm, Akoranga*

Part 2: Walking in relation to centres (or more generically retail, work etc)

24. What Makes People Use the Street? Towards a Liveable Urban Environment in Kuala Lumpur City Centre

(Rahman et al., 2015) – Malaysia

The study examined factors influencing street usage. It was based around the study area of *Jalan Tunku Abdul Rahman (JTAR),* a main traditional street in the city centre of Kuala Lumphur, Malaysia.

It found five main factors which attract street usage by pedestrians. They are:

- attractions on the street
- activities on the street
- **proximity (commute distance)**
- congestion
- other supportive factors e.g. public space, trees, cleanliness…

In terms of proximity, the study revealed that distance to the street, from a pedestrian's home *and* from their workplace*, was significant in influence street usage.

The interview results showed that the majority of respondents walk around **1 km in distance** to the city-centre street. To them, this was perceived as a reasonable distance or 'not too far' for walking-transit purposes.

25. Beyond the Quarter Mile: Re-examining Travel Distances by Active Transportation.

(Larsen et al., 2010) – Montreal, Canada

The paper is based on the 2003 Montreal Origin-Destination Survey. Importantly, it focuses on walking trips where a second transit mode is not the intended destination (e.g. a rapid transit station).

The study finds that the overall **median walking distance** (as per the OD survey) **is 650m;** exceeding the general 400m catchment radius. Further, it found that for many trip purposes, the **85th percentile of walking distances exceeds 1000 m.** To elaborate:

Walking trip purpose	**85th percentile (distance)**
Overall	1,403 m
Work	1789 m
Shopping	1327 m
School	1243 m
Leisure	1572 m

The author notes – "the **85th percentile values** can be used in defining catchment areas around existing and new destinations" (p. 76).

26. Walking as a local transport modal choice in Adelaide

(Allan, 2001) – Adelaide, Australia

The author refers to the typical walking capacity of a 'normal healthy adult' as 6km/h. He considers that a walker would typically be able to maintain a speed of 6km/h for up to 20 minutes, before this rate declines from fatigue or other factors.

As such, he proposes that **a 20-min walk (i.e. 2km) is reasonable distance** in Australian urban environments (p. 39).

27. Myths and Realities in Walkable Catchments: The Case of Walking and Transit

(Ker & Ginn, 2003)

The authors refer to the study of Pikora (2003) – [could not access original source]; who found that **75% of survey respondents walked over 800m to access various destinations.** 48% of respondents reported walk trips to shops.

28. Permeability and interface catchment: measuring and mapping walkable access

(Pafka & Dovey, 2017)

The authors refer to the study of Gruen (1965) – [could not access original source]; who indicated **the average walking distance may be up to 1,500m** depending on the built environment (e.g. whether it is supportive of walking) and extent of protection against weather.

29. The relationship between cluster-analysis derived walkability and local recreational and transportation walking among Canadian adults.

(McCormack et al., 2012) – Calgary, Canada

The study investigates the relationship between neighbourhood walkability and walking rates in adults. Walkability is assessed on an objective scale, via a built environment profile.

The study employed a catchment area with a 1600m radius, **citing consistency with other studies** (Oliver et al., 2007) – p. 1081. This area was determined in this paper and others, as a suitable distance walked within 15 mins.

30. Identifying destination distances that support walking trips in local neighbourhoods

(Gunn et al., 2016) – Victoria, Australia

The study investigated the relationship between distance and walking trips to local food destinations (supermarkets, cafes, takeaway stores, small food stores, etc.). It tested the difference in walking levels between two 'donut buffers' of 401-800m, and 800-1200m.

It found that in local neighbourhoods, food destinations at distances between 401m – 800m were associated with higher levels of walking trips; compared to placements at distances of 800-1200m. This suggests that a closer proximity encourages greater walking prevalence.

31. Experimental research of pedestrian walking behavior

(Daamen &Hoogendoorn, 2003)

The article is concerned with designing for walking infrastructure (e.g. transfer stations or shopping malls, etc.), pedestrian behaviour and **transfer times** (i.e. time to move from one place to the next).

First, it recognizes that conventional design methods are based on rules of thumb – which consider passenger behaviour in **static situations** only. Many dynamic implications are unaccounted for, such as differences in passengers (e.g. elderly who may require longer transfer times).

To gain more accurate estimations of transfer time, the study integrates more detailed pedestrian flow data. The purpose is to better understand pedestrian flows at both microscopic and macroscopic levels.

It considers:

- Walking speed
- Collective behaviour and self-organisation (e.g. pedestrian flows in different directions self-separate into 'lanes')
- Walking behaviour and interaction

Notably, the study found:

- **Free speed *(speed as desired or when unhindered by other pedestrians)* was on, average, 1.58m/s.**
- In pedestrian bottleneck situations:
  - In free-flow conditions: pedestrians walk in the centre of the bottleneck; away from walls.
  - In capacity conditions: pedestrians self-separate into lanes and walk diagonally behind one another – to use the bottleneck space more efficiently.

32. Shaping neighbourhoods: A guide for health, sustainability and vitality.

(Barton et al., 2003)

Brief info found on: ***Comparative study of neighbourhood walkability to community facilities between two precincts in Putrajaya*** *– (Azmi et al., 2013).*

Azmi et al. (2013) referred to the works of **Barton et al. (2013).**

The latter indicated that the maximum walking distance and times typical of pedestrians, in order to access neighbourhood facilities and services, were as follows –

Community facilities/services	Maximum walking distance	Maximum walking time
▪ local shop ▪ bus stop	400 m	~ 5 min

Community facilities/services	Maximum walking distance	Maximum walking time
▪ nursery school ▪ primary school ▪ community facilities	600 m	~ 7 min
▪ local centre ▪ post office ▪ restaurant	800 m	~ 10 min
▪ secondary school	1000 m	~ 12 min
▪ district centre * ▪ superstore ▪ leisure centre	**2000 m**	**~ 25 min**

* district centre – potentially relevant to metropolitan centre or city centre catchment

33. The neighbourhood unit: How does Perry's concept apply to modern day planning?

(Olson, 2010) – webpage

This is a very brief webpage article. It focuses on Clarence Perry's 'Neighbourhood Unit' concept. Fundamentally, the concept employs a 5-minute walk rule, as the suitable walking distance from residential to non-residential areas of the neighbourhood.

Importantly, the design is based on the 'human factor' – all distances calculated were intended for the human foot rather than motorized transport. Walkability is a crucial attribute. Other key components of the design included: narrow streets, mixed usage & a max. 3-min walk to the local park.

34. Normal walking speed: Average human walking pace.

(Patricia, 2010) – webpage

This brief article conveys the diversity of walking capacity amongst individuals. It varies based on age, level of fitness, gender, height, weight, etc.

Generally, walking speed is approximately 3 to 4 miles **(4.8 to 6.4 km) an hour.** This most likely decreases with age, to roughly 2.5 to 3 miles **(4 to 4.8 km) an hour.**

35. Access to Destinations: How Close is Close Enough? Estimating Accurate Distance Decay Functions for Multiple Modes and Different Purposes.

(Iacono et al., 2008) – Twin Cities, U.S.

The study examines distance decay effects upon various transit modes, for various trip purposes. In terms of walking, the following relationship (distance/percentage of walking trips) was found:

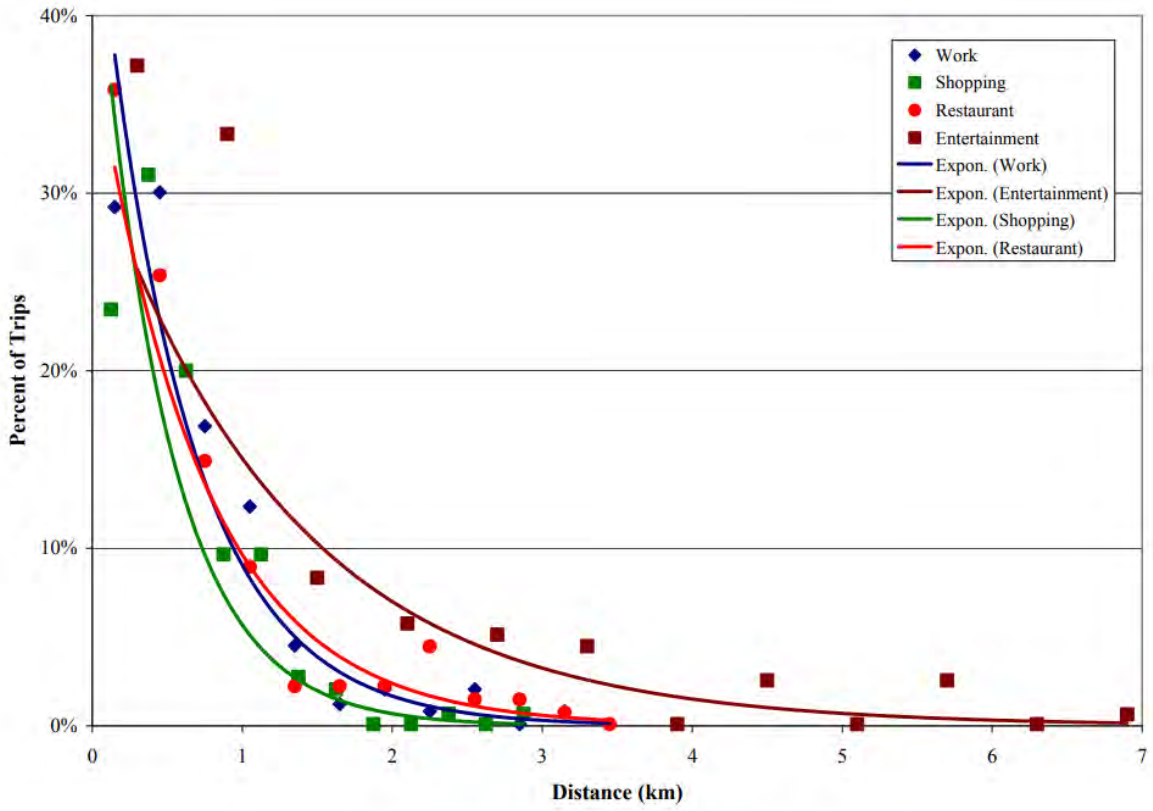


Figure 1. Distance Decay Curves for Walking Trips

Key points:

- Trips for work, shopping and restaurants are generally shorter than for entertainment (recreation).
- The majority of walk trips are under 3 km.
- A notable number of trips **reach or exceed 1km in distance**. This indicates that many pedestrians are prepared to walk much further than the general 400m radius assumed in planning. The consistency of the result across the trip purposes shows that this sentiment goes beyond recreational purposes; applying also to active transit walk trips.

- To further back this up, the authors calculated that **between 1/4 to 1/3 of pedestrian travel surpassed 400m** (p. 7).

36. The relationship between destination proximity, destination mix and physical activity behaviors

(McCormack et al., 2008) – Western Australia

The study assessed the relationships between destination proximity, destination mix and physical activity. In particular, it compared the effect of destinations within 400m versus 1500m, as the distance(s) from respondents' homes.

Results revealed that, **for purposes of active transport**, proximity and mix were strongly related to walking levels. Transport walking was strongly associated with:

- Access within 1500m to: schools, transit stations, shopping malls, convenience stores and news agencies.

- Access within 400m to: post boxes, bus stops, transit stations, shopping malls, convenience stores, news agencies.

In particular, the authors noted that for **less common destinations such as transit stations, a 1500m buffer is more appropriate** – due to the relative rarity of the destination, and the limited number of people who could access it within 400m.

37. Destination and route attributes associated with adults' walking: a review.

(Sugiyama et al., 2012) – Review

The paper synthesizes the findings of 46 articles on matters of utilitarian (active transport) walking and destination & route attributes.

Utilitarian walking corresponded to the presence & proximity of utilitarian destinations (shops, services, transit stops) – consistent across **80% of the studies reviewed.**

Though this paper confirmed the association with proximity, it did not offer a definitive measure on what was considered a walkable distance.

38. Associations of the perceived and objective neighborhood environment with physical activity and sedentary time in New Zealand adolescents.

(Hinckson et al., 2017) – Auckland & Wellington

The study aims to approximate the relationship between walkability components and physical activity & sedentary time. Data was collected from 524 individuals.

- Walkability components: include GIS-determined and perceived factors – i.e. objective & subjective.
- Physical activity: moderate-to-vigorous physical activity (MVTA)
- Sedentary time: (ST)

Objective (GIS-determined) factors:	**Subjective** (perceived) factors:
▪ gross residential density ▪ street intersection density ▪ cul-de-sac density ▪ transit stop density ▪ number of parks ▪ land use mix	▪ residential density ▪ land use mix – diversity ▪ land use mix – access ▪ street connectivity ▪ walking facilities ▪ aesthetics ▪ pedestrian/automobile traffic safety ▪ crime ▪ parking difficulty in local shopping areas ▪ physical barriers to walking ▪ hilly streets

Results (p. 144) found:

- very minor associations between **objective factors** and physical activity
- very minor associations between **objective factors** and sedentary time
- 3 of 11 **subjective factors** were significantly associated with physical activity *(land use mix – diversity, street connectivity, aesthetics): positively associated with MVTA.*
- 5 of 11 **subjective factors** were significantly associated with sedentary time *(land use mix – diversity, street connectivity, aesthetics, pedestrian/automobile traffic safety): negatively associated with ST; (physical barriers to walking): positively associated with ST.*

In conclusion, the study found that **subjective (perceived)** variables have greater relationships with physical activity and sedentary time; indicating a greater influence.

39. Built environment correlates of walking: a review.

(Saelens & Handy, 2008) – Review

The paper focuses on the association between built environmental variables and walking. It is a review of previous studies, including 13 other reviews. The 2008 review found that:

(i) Transportation and density, (ii) distance to non-residential destinations, and (iii) land use mix: have consistently positive associations with walking.

- Land use mix: means destinations are more proximal to users. Thus, the review considers that findings for this variable are consistent with that for accessibility.
- Density: is also considered as related to proximity, because higher density indicates more people to support various activities are located nearby; thus destinations to these activities are closer.

(i) Route/network connectivity, (ii) parks and open space, and (iii) personal safety: have more ambiguous relationships with walking.

Also noted:

- There were lesser findings for aesthetics, accessibility of physical activity facilities, and traffic (p. 7).
- There were minimal findings for children's walking.

40. Correlates of Walking for Transportation or Recreation Purposes.

(Lee & Moudon, 2006) – Seattle, U.S.

438 adults were surveyed, to determine the association of (i) objective and (ii) subjective environmental conditions with transportation walking versus recreational walking.

It found that:

- For transportation walkers, there is a significant relationship between walking and destination proximity. The closer respondents were to the destination (grocery store, restaurant, post-office or bank), the higher the likelihood of walking.

The following: *[Adapted from Saelens & Handy, 2008]*

- Individuals were more likely to be transportation walkers if:
  - they perceive the area as diverse in uses
  - the area has lower residential density
  - closer proximity to bank
  - further distance from [office & other land use] combinations

- Frequent transportation walkers:
  - have lesser slope in their route (flatter terrain)
  - closer to grocery store, restaurant, post office & bank
  - higher parcel density

- Moderate transportation walkers:
  - perceive the area as diverse in usage
  - routes are less direct to closest church
  - closer to bank

41. Linking objectively measured physical activity with objectively measured urban form: findings from SMARTRAQ.

(Frank et al., 2005) – Atlanta, U.S.

The study is focused on the relationship between urban form and physical activity; both in objective measures.

- Physical activity was measured by: an activity monitor.
- Urban form was measured by: residential density, street connectivity, land-use mix; determined by mathematical calculations to yield a walkability index.

It found that:

- There is indeed a positive association between the urban form and physical activity (at moderate intensity) in adults.

- *Moderate physical activity* [greater than 30 minutes, on a random day] is **more likely for individuals who live within close proximity to many destinations, & with direct pathways to those destination.**

- Individuals in the highest walkability quartile were 2.4 times more likely to engage in *moderate physical activity* than individuals in the lowest walkability quartile. (p. 117)

The findings indicate that policies facilitating more walkable urban forms (via residential density, street connectivity & land use mix) will promote walkability & public health.

42. Neighborhood built environment and transport and leisure physical activity: findings using objective exposure and outcome measures in New Zealand.

(Witten et al., 2012) – New Zealand

The study examined the relationship between neighbourhood built environments (destination access, street connectivity, dwelling density, land-use mix and streetscape quality) and transport-related physical activity (self-reported and accelerometer-derived).

Walkability indexes were generated from the neighbourhood built elements and to GIS. The scores were then used to select 6 high and 6 low walkability study neighbourhoods per city.

Data was collected via a survey of 2033 adults, across 48 neighbourhoods of 4 cities. The results found that:

- Though over car access prevailed at 82.2%, a more walkable neighbourhood was favoured by 34.9% (the largest share) – p. 974.

- **Street connectivity, destination accessibility, and dwelling density**: were positively correlated to higher levels of physical activity (PA) – *self-reported and accelerometer-derived.*

- For these three factors, each increase in standard deviation (SD) generally led to a 7% increase in accelerometer-derived PA (p. 975).

    - Further, these three factors were highly correlated with one another. They were also correlated with neighbourhood-level deprivation (i.e. more deprived neighbourhoods observed higher dwelling density, etc.).

- The remaining two factors – streetscape and land-use mix: had lower associations with self-reported PA. The relationships were generally non-significant, or weak.

- For accelerometer-derived PA, land-use mix was related to a smaller but notable increase in activity (3-4%), for each SD increase.

43. Proximity to Trails and Retail: *Effects on Urban Cycling and Walking.*

(Krizek & Johnson, 2006) – Twin Cities, U.S.

The study investigates whether the presence of neighbourhood retail within walking distance would increase the likelihood of walking.

Neighbourhood retail establishments included:

- *Food and beverage stores*
- *Health and personal care stores*
- *Clothing and accessory stores*
- *Sorting goods, hobby, book and music stores*
- *General merchandise stores*
- *Miscellaneous stores*
- *Food services and drinking places*

Distances studied were categorized into the following:

- Less than 200 m
- 200 to 399 m
- 400 to 599 m
- 600 m or more

This allowed results to be compared between different distance groups. The results found that:

- Those **living within 200m of retail shops** were the only group with increased likelihood of walking (to a statistically-significant extent) – compared to those living 600m away or further. (p. 39).

- Further, the authors note that "the presence of children was the only household characteristic that had a significant influence" (p. 39).

From these results, the authors concluded that proximity to retail matters, as a factor influencing walking, but the relationship is not linear. Closer distances are of more significance, in impacting decisions to walk.

The authors believe the results conflict with the quarter-mile (400 m) assumption typically implemented by transport planners. Unlike other studies, they suggest **nearer** distances are required to incentivize walking.

44. Systematic literature review of built environment effects on physical activity and active transport - an update and new findings on health equity.

(Smith et al., 2017)

The study investigates the environmental interventions that enhance local physical activity. Consistently, there was a positive correlation **of:** walkability components, parks and playgrounds, & installation/improvement of active transport infrastructure, **with**: active transport, physical activity and usage of urban settings. (p. 21).

The authors also observed some non-specific relationships – e.g. installing fitness or playground equipment coincided with increased active transport to that locality.

- Positive impacts were consistent across children and adults.

The authors then considered, (drawing from findings of other studies), the variation of these positive intervention effects in different ethnic & socioeconomic groups. They noted the following observations:

- One study found usage of new walking & cycling paths were dominated by: higher income, higher education, and employed groups.
- Another study found that park improvements saw increased usage by white ethnic groups; but observed no significant difference for black, Hispanic, or other users.

Thus, there is indication that environmental improvements may disproportionately benefit socioeconomically-advantaged groups.

45. Walking Distance by Trip Purpose and Population Subgroups.

(Yang & Diez Roux, 2012) – U.S.

The study investigates the levels of walking, and walking trip distances & durations. It utilized data from the 2009 National Household Travel Survey, from which a distance-decay function was derived.

It found the following:

- For the **16.4%** of respondents who had at least one walking trip per day – their trips had the following averages:

	Mean		Median	
Distance	0.7 miles	**1100 m**	0.5 miles	**800 m**
Duration	**14.9 mins**		**10 mins**	

- Around 65% of walking trips were over 0.25 (400 m).
- Thus, while walking is found in only a small share (16.4%), it is common for walking trips to exceed 400m.
- However, distances and duration also varies by purpose. The above figures were overalls, and included recreational walking & pet-related walking. These are more leisurely in nature than transit, and often have longer distances/durations.
- For distinctive figures on active transport **by purpose**, the following statistics are provided, for elaboration. (p. 15).

Work

	Mean	
Distance	0.3 miles	**480 m**
Duration	2.7 mins	

Study

	Mean	
Distance	0.18 miles	**290m**
Duration	4.4 mins	

Shopping

	Mean	
Distance	0.08 miles	**130 m**
Duration	1 min	

Social events

	Mean	
Distance	0.18 miles	**290 m**
Duration	4.3 mins	

Recreation

	Mean	
Distance	0.47	**756 m**
Duration	9.8 mins	

46. Cities for People – Chapter 4.2

(Gehl, 20120)

The average walking speed is 14.2 min per kilometer in summer; 10.3 min per kilometer in winter.

- *Note that these time estimates are on the basis that pedestrians are unimpeded in their path and the area is uncrowded, unobstructed, and walker-friendly.*
- *For diverse people, this means different things. The degree of path wideness & quality may differ based on the needs of people pushing strollers, disabled pedestrians, etc.*

In general terms, **a 500m walk is widely accepted as an appropriate walking distance (p. 134).**

However, this is not unequivocally so. An acceptable walk is also dependent on additional variables, such as –

Factors enhancing walkability:

- Quality of path
- Comfort of route
- An interesting route
- Rich in experiences – e.g. visual, sensory
- Manageable segments
- Pleasant streetscape, landscaping, greenery
- Ramps – friendly to diverse individuals & needs
- Good lighting

Impediments to walkability:

- Car-dominated design, prioritizing vehicles
- Pedestrians becoming alienated to the side of passageways
- Crowded sidewalks
- Subsequent shoving – unfriendly particularly to disabled, children & elderly
- Sidewalk interruptions: entrances, garages etc. (e.g. parking lot entrances)
- 'Tiring length perspective' – when you can see an entire route before even embarking, seemingly endless, no prospect of novel/interesting factors
- Steps & staircases – not accessible to all
- Cobblestones: in excess, the unevenness is unfriendly to rolling pedestrian traffic, pedestrians wearing heeled footwear, etc.

The authors notes the significance of these factors in impacting the distances individuals are willing to walk.

47. A review on the effects of physical built environment attributes on enhancing walking and cycling activity levels within residential neighborhoods.

(Wang et al., 2016)

This is a comprehensive review on existing literature on environmental elements which enhance or impede walkability. In terms of the focal issue [distance] – the paper refers to McCormack et al., (2008) which has already been discussed – [no. 36].

48. Neighbourhood Destination Accessibility Index: A GIS Tool for Measuring Infrastructure Support for Neighbourhood Physical Activity.

(Witten et al., 2011) – New Zealand

The paper is concerned with measures for pedestrian access to neighbourhood destinations – categorized into 8 groups: (education, transport, recreation, social & cultural, food retail, financial, health, and other retail).

However, it focuses on the variation of these destination opportunities amongst different neighbourhoods and socioeconomic communities.

It does not provide any conclusions on distance – only utilizes the 800m buffer typically assumed in literature, as a measuring of defining pedestrian access.

49. The Problem of Catchment in Centres-based Residential Growth Planning.

(Munro, 2009) – New Zealand

The paper notes that: "the 800m circle has become accepted as representing a convenient 10 minute walk for most people in a community (based on a walk speed averaging 1.3m/s across the journey and including minor delays)" – (p. 2).

As such, the author **adopts** the 800m walking distance as the basis for assuming walkable catchment sizes for the rest of the paper.

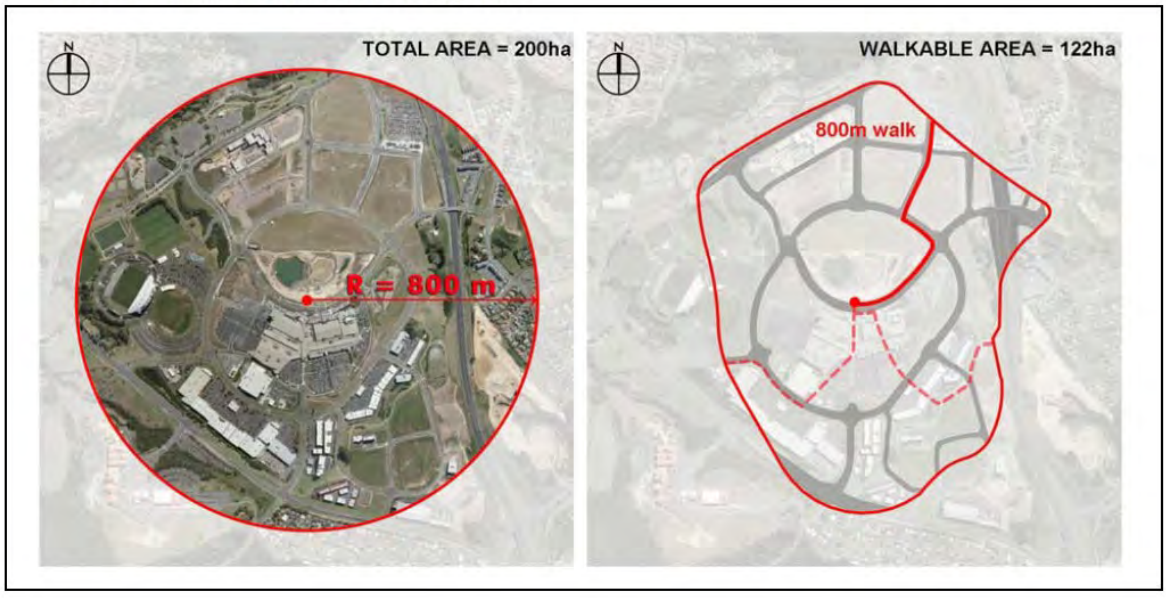
Munro notes that:

- "The 800m radius circle needs to be **reduced to an 800m walkable catchment**" – (p. 5).

It appears that he contends 800m should be the actual distance or path travelled; not a linear 800m *radius* that disregards actual environmental characteristics and their implications on walking. In particular, due to divisions in the urban fabric (highways, rivers, large urban blocks), the actual distances travelled (or that can be travelled) will differ from what is represented by a straight 800m line.

The below figure (p. 6) is provided in his case study of Albany centre.

FIGURE 2: Walkable catchment of Albany centre.



The first image represents an 800m radius; but it is adjusted in the second image to represent an 800m walk. The actual paths are shown – which are not linear, straight lines. Thus a reduction in space is necessary, to produce a more accurate walkable *catchment*.

The paper then focuses on the issue of developable land within an 800m catchment. Munro argues that, for residential purposes, the actual developable area in a catchment is quite limited, due to an abundance of space being allocated to:

- necessary infrastructure (roads, open spaces, etc.)
- business zones & office zones etc.
- separation of 20m (minimum) between buildings as per AUP standards
- common spaces in residential buildings (e.g. terrace housing/apartments) which will not be built on.

Therefore, only a small portion of the catchment can actually be developed.

50. Consumer Behavior and Travel Mode Choices

(Clifton et al., 2012) – Portland

The paper is focused on the association between consumer behaviour and travel mode choices, to destinations at a local level.

Data was collected via surveys, at 78 establishments across Portland. They were further categorized into convenience stores, high-turnover restaurants, and drinking places. Overall, walking accounted for 25% of the mode share to these destinations.

More detailed figures are below, for mode share:

Table 2. Percent Mode Shares by Area Type and Land Use

Area Type & Land Use	Automobile Mode Share	Walk Mode Share	Bicycle Mode Share	Transit Mode Share
Convenience	58%	27%	7%	6%
Central Business District	34%	49%	10%	10%
Urban Core	52%	31%	9%	6%
Regional Centers	60%	26%	7%	5%
Suburban Town Centers	70%	18%	3%	7%
Suburban Areas	72%	14%	8%	3%
High-turnover Restaurant	63%	22%	8%	6%
Central Business District	35%	42%	7%	16%
Urban Core	65%	20%	13%	2%
Regional Centers	70%	24%	6%	1%
Suburban Town Centers	85%	6%	1%	6%
Suburban Areas	86%	5%	0%	8%
Drinking Place	43%	27%	22%	7%
Central Business District	26%	40%	19%	15%
Urban Core	46%	20%	25%	8%
Regional Centers	52%	30%	18%	1%
Suburban Town Centers*	N/A	N/A	N/A	N/A
Suburban Areas*	N/A	N/A	N/A	N/A
Overall	58%	25%	9%	7%
Central Business District	34%	43%	9%	14%
Urban Core	57%	23%	15%	5%
Regional Centers	61%	26%	10%	3%
Suburban Town Centers	79%	11%	2%	7%
Suburban Areas	78%	10%	5%	5%

*Drinking places were not surveyed in suburban area types

Distance: Unsurprisingly, **pedestrian** trips to these destinations were found to be of the shortest distances; **averaging 0.7 miles (~1127m).** However, the authors note that this distance exceeds conventional planning guides by far.

The rest of the study focused on the interesting discovery that travelling longer distances to various destinations (restaurants/bars) was associated with slightly higher spending habits. However, this was *not* specific to the walking mode share.

51. People + Places + Spaces – A design guide for urban New Zealand

(Ministry for the Environment, 2002) – New Zealand

In particular, walkability (distance) is discussed under two urban design principles:

- Consolidation and dispersal

Consolidation is the practice of 'creat(ing) critical mass and bring(ing) vitality to an area by supporting more businesses and service activities, greater street life and more movement.' – p. 33. As a result of consolidation, the area becomes safer and more vibrant; encouraging foot traffic & pedestrians to frequent the area.

In terms of consolidation, the design guide recommends urban nodes to be defined as walkable catchments. A walkable catchment should be 400m (5 min) from shops or bus stops, and 800m (10 min) from rail stations. (Fig 1)

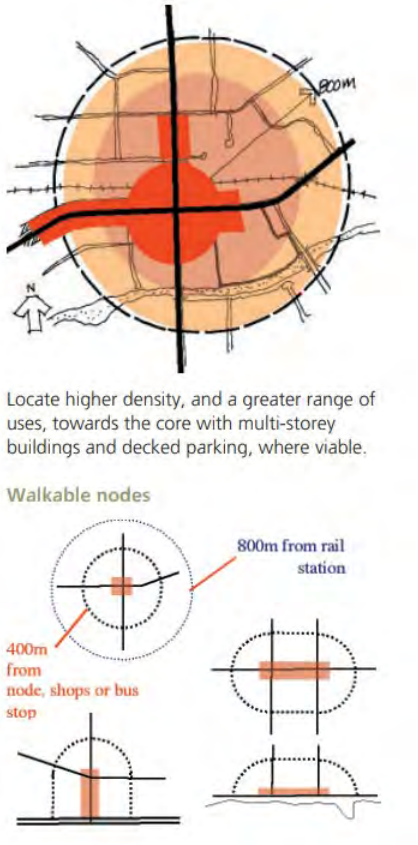
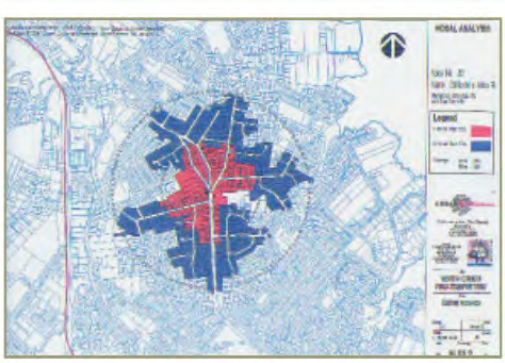


Figure 1 – p. 43



A 'pedshed' effectively measures the efficiency of pedestrian access to the centre of a node. Here the areas within 400m (red) of a bus stop or neighbourhood centre, and 800m (blue) of a town centre or rail station, are tested. The areas within actual safe walking distance (400m or 800m) of the node are shaded. These are compared with the theoretical area within the radius. Aim for 70 percent of the area or more. Efficiencies can be improved with new linkages, or by shifting the centre, as was done with the rail station at Glen Eden.

Figure 2 – p. 44

- Integration and connectivity

This refers to the facilitation of movement via street patterns; enhancing the convenience and enjoyment of walking/cycling.

Here, a 'pedshed' is referred to, though in the same vein. Similarly, a pedshed should encompass areas 400m from a bus stop or **neighbourhood centre**; or 800m from a rail station or **town centre.**

Here, a distinction is made between a 400m/800m linear radius versus 400m/800m **actual safe walking distance** (Fig. 2).

52. Urban Design Toolkit

(Ministry for the Environment, 2006) – New Zealand

- Walkability analysis / pedshed analysis (p. 17)

This is a technique to measure the population catchment encompassed within a 5-10 minute walk from an activity, transport stop or node (p. 17).

It is used by overlaying a fixed-diameter circle upon a map. The circle radius is typically based on the assumption of an average person walking 400m within five minutes, or 800m within ten minutes.

53. Planning Advice Note – Master Planning

(Crowan, 2008) – Scotland

The reading is mainly focused on the process of preparing & executing a masterplan.

There is little mention of walking– 4 times within 75 pages. These mentions are very general; pertaining to sustainable travel – e.g. promote & enhance walkability.

There is no definition of an acceptable walking distance, nor of catchments.

54. The Urban Design Compendium

(Llewelyn-Davies, 2000) – U.K

Walkable neighbourhood (p. 35). To facilitate ease of walking, the following distances are recommended:

- to post box or telephone box: **250m**
- to newsagents: **400 m**
- to local shops, bus stop, health centre, (possibly) primary school: **800m**

Public access to open space (p. 57)

- Ideally, parks should be located within **250-400m** walking distance from most homes.

Public transport catchments (p. 74)

- "A bus route will be viable if there are enough people within a **400m radius** (5 minutes walk) of each stop."

- The ideal catchment per stop for different forms of public transit is shown below (p. 74):

Table 4.1 Catchment areas for public transport

	Minibus	Bus	Guided bus	Light rail	Rail
Stop interval	200m	200m	300m	600m	1,000m+
Corridor width / area served	800m	800m	800m	1,000m	2,000m+
Catchment per stop	320 – 640	480 – 1,760	1,680 – 3,120	4,800 – 9,000	24,000 – 24,000

- However, the paper consistently uses a 400m radius as a benchmark which is recognized as a typical, widely-used standard in mixed-use neighbourhoods (p. 41). See below:

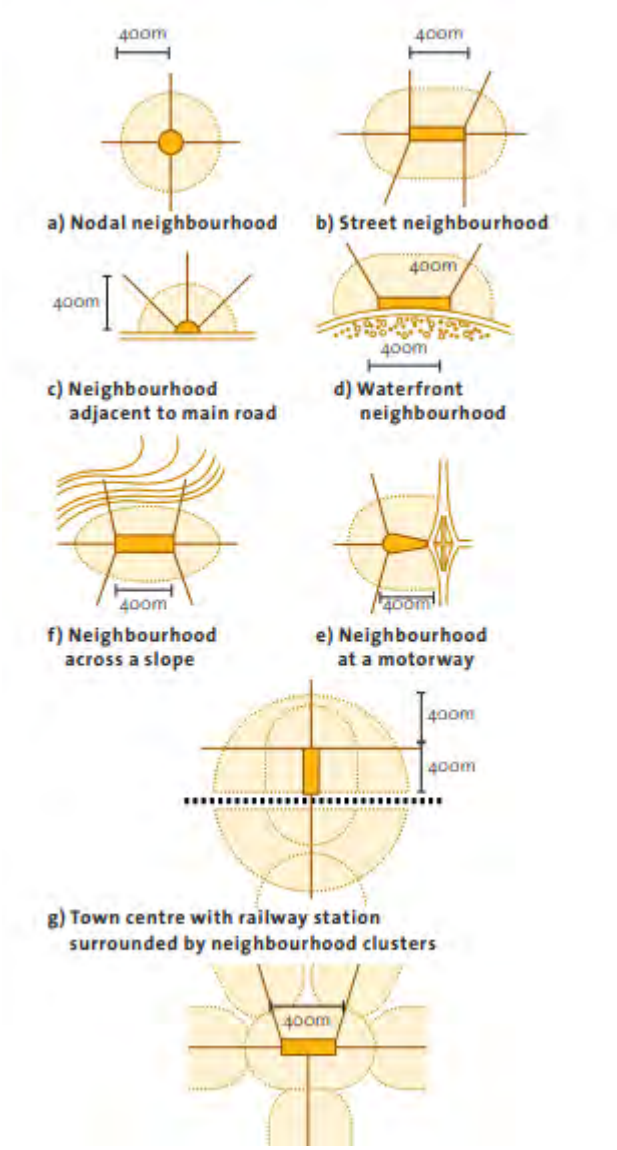


Figure 3 - p. 41

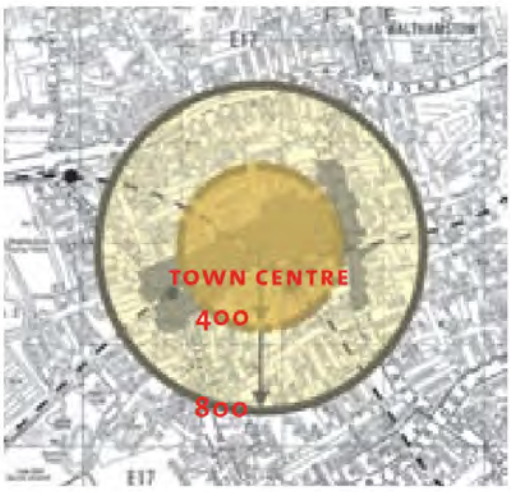


Figure 2 - p. 36

55. Human Walking Analysis Assisted by DGPS

(Ladetto et al., 2000)

This paper does not provide information on preferred walking distances.

Instead, it is focused on finding a suitable approach to calibrate human walking patterns; framed by a broader objective to understand the daily activities of individuals. In particular, it is concerned with differing stride lengths – the variability of which impacts 'dead reckoning for on foot navigation' (p. 2). In response, the paper puts forward an approach to calibrating strides, 'as a basis for global pedestrian dead reckoning applications' (p. 2).

The approaches used to calibrate dead-reckoning distances for vehicles are unsatisfactory for that of pedestrian travel. This is due to issues like the lack of consistency in human walking, the constant factors impacting walk variability, and, statistically, because systematic errors are too significant – such as in small Inertia Measurement Unit (IMU).

The author proposes Continuous Step Calibration method in order to avoid distance errors otherwise encountered by alternative techniques.

56. Urban liveability: Emerging lessons from Australia for exploring the potential for indicators to measure the social determinants of health

(Badland et al., 2014)

This paper:

- connects liveability and social factors for health
- synthesizes liveability indicators developed as of 2014
- evaluates their quality through a health/wellbeing paradigm.

It is based on 114 academic/policy documents and reports; from which 233 indicators were funnelled through based on relevance, arriving at **11 domains of** liveability – 'likely contribut(ing) to health and wellbeing through the social determinants of health' (p. 64).

They are:

- crime and safety
- education
- employment and income
- health and social services
- housing
- leisure and culture
- local food and other goods
- natural environment
- public open space
- transport
- social cohesion and local democracy

No explicit distances were mentioned in terms of walking. However, the following were related to walkability:

Transport (p. 70)

- Walkable environments may enhance transit via walking, cycling and public transport – encouraging recurrent physical activity, preventing disease and obesity (Beaglehole et al., 2011).
- Inequalities may also be addressed through walkable environments to significant destinations, thus providing lower-cost, feasible options.

Local food and other goods (p. 69)

- Shops within walking distance enhance active travel patterns (Staffford et al., 2007b).

The Stafford study was reviewed to see if it offered any definition of a walkable distance. The paper (Pathways to obesity: Identifying local, modifiable determinants of physical activity and diet) was largely related health/wellness. In terms of distance: it retained 'Distance to the post office' as a standard in their model, for predicting obesity. The median distance was 366m. (Stafford et al., 2007, p. 1888).

> *Stafford, M., Cummins, S., Ellaway, A., Sacker, A., Wiggins, R., & Macintyre, S. (2007). Pathways to obesity: identifying local, modifiable determinants of physical activity and diet. Social Science & Medicine 65, 1882e1897.*

Education (p. 68)

- Walkability of the urban environment surrounding schools is an optimistic indicator for liveability (Community Indicators Victoria, 2013).

57. Walking to scale: an index to assess walkability at the residential scale.

(Forsyth, 2016) – Auckland, NZ

This paper develops a **residential-scale walkability index** as an alternative approach from aggregate data & areal *neighbourhood* analysis; (as the latter results in statistical errors and is limited in its application, to only the specific area studied).

Thus, the author proposes a disaggregate approach to forming residential scale walkability indexes (as opposed to the neighbourhood scale).

Incorporated in the study are the factors of **population density, street connectivity, diversity of land use** – which the author finds to be the key metrics of walkability, through a review of literature.

As part of the method, a residential-scale walkability index (RSWI) was developed at the **5 and 10 minute walking scales** (p. i). Notably, the author notes the papers of Learnihan et al. (2022) and Middleton (2009), and observes that '*the **true focus** of a residential scale approach is on the temporal distance, as opposed to the spatial distance'* (p. 15). Consistently, the paper gives greater emphasis to temporal distances.

In particular, the flexibility of the RSWI approach means that it is tailorable to different subpopulations – such as for children or the elderly who may be able to walk much shorter distances compared to the general population (p. 71).

Overall, the major finding of the study is that measuring walkability at a residential scale (as an index) is feasible and arguably a better option than standard neighbourhood-scale analyses – by overcoming problems (e.g. the lack of standardization) observed in the latter (p. 84).

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