

SEIZING THE OPPORTUNITY?
HOW SUSTAINABLE URBAN DESIGN WILL FEATURE IN THE REDEVELOPMENT OF THE
CENTRAL CITY OF CHRISTCHURCH TO REDUCE CO₂ EMISSIONS FROM LAND
TRANSPORT

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Abstract

Following devastating earthquakes in 2010 and 2011 in Christchurch, there is an opportunity to use sustainable urban design variables to redevelop the central city in order to address climate change concerns and reduce CO₂ emissions from land transport. Literature from a variety of disciplines establishes that four sustainable urban design variables; increased density, mixed-use development, street layout and city design, and the provision of sustainable public transport, can reduce car dependency and vehicle kilometres travelled within urban populations- widely regarded as indicators of the negative environmental effects of transport.

The key question for the research is; to what extent has this opportunity been seized by NZ's Central Government who are overseeing the central city redevelopment? In order to explore this question the redevelopment plans for the central city of Christchurch are evaluated against an adapted urban design matrix to determine whether a reduction in CO₂ emissions from land transport is likely to be achieved through their implementation. Data obtained through interviews with experts is used to further explore the extent to which sustainable urban design variables can be employed to enhance sustainability and reduce CO₂ emissions.

The analysis of this data shows that the four urban design variables will feature in the Central Government's redevelopment plans although the extent to which they are employed and their likely success in reducing CO₂ emissions will vary. Ultimately, the opportunity to redevelop the central city of Christchurch to reduce CO₂ emissions from land transport will be undermined due to timeframe, co-ordination, and leadership barriers.

Key words: Urban design, urban development, climate change, transport.

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List of Abbreviations

CCC	Christchurch City Council
CCDU	Central city Development Unit
CERA	Canterbury Earthquake Recovery Authority
CNU	Congress of New Urbanism
CO ₂	Carbon dioxide
CO ₂ -e	Carbon dioxide equivalent
ECan	Environment Canterbury (Regional authority)
Gg	Gigagram
Gt	Gigatonne
GHG	greenhouse gas
IPCC	Intergovernmental Panel on Climate Change
LRT	Light rail transit
MfE	Ministry for the Environment
MoT	Ministry of Transport
NZCID	New Zealand Council for Infrastructure Development
NZTA	New Zealand Transport Agency
PCE	Parliamentary Commissioner for the Environment
PPM	parts per million
PT	Public transport
RMA	Resource Management Act
TOD	Transit Oriented Development

TTI	Texas Transportation Institute
UDS	Greater Christchurch Urban Development Strategy
UN	United Nations
UVF	Urban Villages Forum
VKT	Vehicle kilometres travelled

Chapter 1 Seizing the opportunity? Earthquakes, climate change, and urban design

In 2010 and 2011, large earthquakes struck the Canterbury region causing severe damage to the central city of Christchurch, New Zealand's (NZ) third largest city. The extent of the damage is so severe that the city must now embark upon a significant redevelopment phase. This presents a unique opportunity to redevelop the central city of Christchurch in an innovative and sustainable way that reflects modern urban design and planning principles and can correct the planning mistakes of the past (Gjerde, 2012). Importantly the redeveloped central city will need to be designed with the issue of climate change in mind, and those responsible for planning the post-earthquake central city will need to consider climate change mitigation techniques that can create a Christchurch that is resilient to the impacts of a carbon constrained world.

1.1 Climate change

Climate change and associated impacts is the biggest crisis that the world is facing today and the management of this problem will be the defining challenge of this century (Stern, 2010). In the United Nations Framework Convention on Climate Change (UN, 1992, p. 7) climate change is defined as 'a change of climate which is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and which is in addition to natural climate variability observed over comparable time periods'. Carbon dioxide (CO₂) is considered to be one of the most significant greenhouse gases (GHG) due to its abundance and long atmospheric lifetime of approximately 50 to 200 years (Davoudi, Crawford, & Mehmood, 2009; IPCC, 2007; United Nations Human Settlement Programme, 2011). The concentration of CO₂ in the atmosphere has increased from 280 parts per million (ppm) prior to the industrial revolution to approximately 379ppm in 2005, and this rapid rate of increase is widely accepted as being due to human activities (IPCC, 2007). CO₂ is released into the atmosphere mainly through the burning of fossil fuels (e.g., to provide energy for transportation), which is responsible for over

75 per cent of anthropogenic greenhouse gas increases since the industrial revolution (IPCC, 2007; United Nations Human Settlement Programme, 2011).

The consequences of the altered energy balance of the climate system due to high atmospheric concentrations of CO₂ are emerging and are demonstrated by increased frequency of major weather events (e.g., droughts, floods and storms), increased mean air temperatures, and sea level rise due to the melting of polar ice caps (IPCC, 2007). NZ will not be immune to these effects and Hennessy et al. (2007) of the Intergovernmental Panel on Climate Change (IPCC) have reported with *very high confidence*¹ that regional climate change is already occurring in this country. This report shows scientific evidence of mean air temperature rise of 0.4- 0.7 degrees Celsius and 70 millimetres sea level rise in NZ since 1950, while more heat waves and fewer frosts have also been recorded since that time (Hennessy et al., 2007). Given that the NZ population is predominantly urban, cities and towns will be key areas for addressing climate change (Bulkeley & Betsill, 2003).

1.2 Cities and climate change

Following a five-fold increase in the global urban population since 1950, approximately 50 per cent of the world's population now live in urban areas (Calthorpe, 2011; Kamal-Chaoui & Robert, 2009; Population Reference Bureau, 2007; United Nations Human Settlement Programme, 2011). Furthermore, urban areas are responsible for the majority of CO₂ emissions worldwide through transport, electricity and heating for homes, and industry (Kamal-Chaoui & Robert, 2009). United Nations (UN) Secretary-General Ban Ki-Moon recently emphasised the importance of urban areas when announcing that the 'global struggle for sustainability will be won or lost in cities' (UN, 2012), as he outlined the UN's prioritisation of sustainable urbanism, which includes a focus on climate change.

1.2.1 New Zealand cities and climate change

Despite an unusual emissions profile for a developed country, in which agriculture accounts for almost 50 per cent of all emissions (MfE, 2007a), urban areas remain an important area where significant CO₂ emissions reductions can be achieved.

¹ IPCC authors assign a confidence level to major statements in reports upon assessment of current knowledge. The confidence level for "very high confidence" equates to at least nine out of ten chance of being correct.

Approximately 87 per cent of New Zealanders live in urban areas (DIA, 2008), which includes settlements with populations over 1000 people as defined by Statistics New Zealand (2013).

Transport is also a major contributor to the country's CO₂ emissions and offers opportunities for substantial reductions. New Zealanders' heavy reliance on the private car for transportation has led to NZ being ranked 2nd of thirty Organisation for Economic Co-operation and Development (OECD) countries in terms of Vehicle Kilometres Travelled (VKT) per person (OECD, 2007). VKT is widely regarded as an indicator of the negative environmental effects of transport (Cervero & Murakami, 2010). Transport accounts for 19 per cent of NZ's total emissions (MfE, 2010), of which the dominant mode, road transport, accounts for 90 per cent (MfE, 2009). The Central Government agencies responsible for monitoring CO₂ emissions and transport statistics report that private car numbers and trip distances are increasing and an associated increase of VKT per person of approximately three per cent occurred between 2001- 2007 (MfE, 2009). Time spent travelling by private car has increased, while time spent travelling by other modes, such as walking, cycling and public transport, has decreased (Ministry of Transport, 2008), resulting in a 68.5 per cent increase of emissions from road transport since 1990 (MfE, 2010).

The Ministry for the Environment (MfE, 2012) recently reported NZ's annual GHG inventory including figures for 2010. This report noted that the energy sector was responsible for 31,107.8 Gigagrams (Gg) of CO₂ equivalent (CO₂-e) of emissions (43.4 per cent of total), as shown in figure 1.1, below. Road transport is the largest source of emissions in this sector, accounting for 12,514.1 Gg CO₂-e (40.2 per cent of energy sector total). From these figures, it is clear that any effective climate change mitigation strategy in NZ must include strategies to reduce CO₂ emissions from road transport.

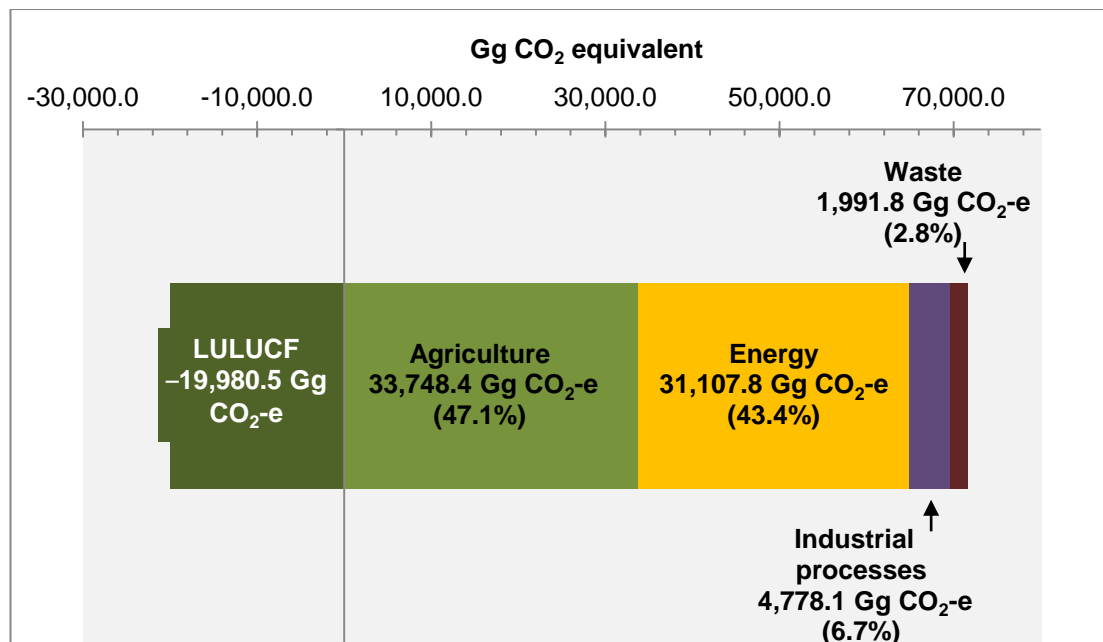


Figure 1.1: NZ's GHG emissions by sector 2010. Source: MfE (2012).

Unfortunately the dominance of road transport is set to continue as use of this mode is intensifying. New Zealanders are driving further, owning more cars, and our cars are becoming older with larger engine sizes (MfE, 2009). Emissions from road transport are expected to increase by 35 per cent by 2030 if preventive measures are not taken (MfE, 2007b). These national level figures are reflected in Christchurch, the case study for this research. In Christchurch, 85 per cent of all trips are conducted by private car, and car travel is growing by 2.5 per cent per year (UDS Forum, 2009).

One reason for NZ's continued dependence on road transport is the design of our urban areas. NZ's urban areas are characterised by low density sprawl without effective public transportation (Auckland Regional Council, 2010) which has exacerbated use of the private car.

1.3 Urban design

Urban design can assist in changing our dependence on road transport and decrease CO₂ emissions. Urban design can be described as 'the design of the buildings, places, spaces, and networks that make up our towns and cities' (McIndoe et al., 2005) and is concerned with how people use urban areas as well as the 'environmental, economic, social and cultural consequences of design'

(McIndoe et al., 2005). Urban design has emerged as a component of several disciplines, including spatial planning- a common approach taken by Central and Local Governments to administer urban form that can be described as a 'set of policy instruments available to regulate and manage land use' (Grazi, van den Bergh, & van Ommeren, 2008, p. 98).

Concern rising from the oil and energy crisis of the 1970s created awareness of the implications of urban form and spurred increased thought and action that generated the sustainable urban design discipline (Girling & Kellett, 2005; Mitchell et al., 2011). Several sustainable urban design movements have emerged since, including the Congress of New Urbanism (CNU), incorporating the Transit-Oriented Development (TOD) concept, and the Urban Villages Forum (UVF). These movements have been influential on modern urban design and planning and are described in table 1.1, below.

Table 1.1: Sustainable urban design movements

Movement	Principles and history
Congress for the New Urbanism (CNU)	<ul style="list-style-type: none"> • Founded in 1994 by a coalition of concerned architects, urban designers, planners, engineers, and citizens to effect change in urban form by promoting walkable, mixed-use neighbourhood development, sustainable communities and healthier living conditions through: <ul style="list-style-type: none"> • Liveable streets arranged in compact, walkable blocks. • A range of housing choices to serve people of diverse ages and income levels. • Schools, stores and other nearby destinations reachable by walking, bicycling or transit service. • An affirming, human-scaled public realm where appropriately designed buildings define and enliven streets and other public spaces. • Promoted the concept of Transit-Oriented Development- a mixed model of regional planning, urban renewal and revitalisation, and walkable neighbourhoods, that centres development around transport systems to shape development patterns.
Urban Villages Forum (UVF)	<ul style="list-style-type: none"> • Founded in 1993 to construct practical examples of urbanist development and to protest against conventional development. Gained acceptance into wider public policy debates- mainly in Europe.

	<ul style="list-style-type: none"> • Promote principles of urban revival, community responsibility, and collaborative partnerships through a combination of pre-industrial urban ideals, such as the organic, holistic, polycentric, and aesthetic nature of villages with contemporary community and management ideals to achieve objectives of sustainability, compact cities, and collaborative planning.
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Sources: Calthorpe (2011); Congress for the New Urbanism (2013); Duany, Plater-Zyberk, & Speck (2000); Franklin & Tait, (2002); Thompson-Fawcett & Bond (2003).

These movements and concepts have offered key principles to decrease CO₂ emissions through sustainable urban design variables of increasing density, enhancing city layout through walkability and connectivity, encouraging mixed-use development, and providing low emission transportation (Congress for the New Urbanism, 1996). Internationally many communities have since been created with these principles in mind and represent working examples of sustainable urban design. Village Homes in Davis, California, the oldest purpose built green neighbourhood, was built in 1975. Further examples have emerged in many places including Orenco Station, Portland, USA, Poundbury, Dorset, U.K., and Hammarby Sjostad, Stockholm, Sweden (Girling & Kellett, 2005; Thompson-Fawcett & Bond, 2003; Wheeler & Beatley, 2009). Many successful examples have also emerged from within existing towns and cities without extensive redevelopment including Curitiba, Brazil, and Copenhagen, Denmark (Wheeler & Beatley, 2009).

1.3.1 Sustainable urban design in NZ

NZ has been slow to enact sustainable urban design initiatives (McIndoe et al., 2005; Parliamentary Commissioner for the Environment, 1998), although examples are emerging including the Beaumont quarter, Auckland (Waghorn, 2011). While there are many case studies and much research outlining successful practice internationally, a research gap has emerged in NZ. Sustainable urban design is context and location specific, therefore international case studies and research may not adequately reflect NZ conditions and may not provide useful comparison and commentary (McIndoe et al., 2005). Recent works from Howden-Chapman, Chapman, and Stuart (2010), and Witten, Abrahamse, and Stuart (2011) have endeavoured to address this concern. A study by Thompson-Fawcett and Bond

(2003) critiquing the Botany Town Centre development in Auckland against a set of urban design criteria contained in a matrix also provides useful NZ context. The current research will adapt the urban design matrix and build on Thompson-Fawcett and Bond's (2003) study to contribute towards addressing the NZ research gap.

1.4 Research aims and objectives

This research aims to answer a central research question:

- How will sustainable urban design variables that reduce CO₂ emissions from land transport feature in the redevelopment of central Christchurch?

To assist in answering this central research question, three sub-questions will also be answered:

1. What are sustainable urban design variables to reduce CO₂ emissions from land transport?
2. How are these variables reflected in the redevelopment proposals for central Christchurch?
3. What barriers exist to implementing sustainable urban design variables to reduce CO₂ emissions from land transport in the redevelopment of central Christchurch?

To achieve this aim several objectives have been developed.

1. Literature-based analysis: to gain an understanding of current sustainable urban design variables and evaluation tools from case studies and research, internationally and within NZ.
2. Planning and policy document analysis: to identify national and regional practice and strategy pre-earthquake, and review post-earthquake documents.
3. Semi-structured interviews: to gain perspectives from planning and policy officials, urban design professionals, and academics on current best practice, future opportunities and barriers to achieving sustainable urban design in the Christchurch redevelopment.

Table 1.2, below, outlines the structure of the thesis, including detail on the content of each chapter and where each research question is answered.

Table 1.2: Thesis structure

Chapter	Detail	Research sub-question
Chapter one	Introduces the topic of the research, establishes the issue of climate change, and provides the NZ context. Research design is briefly outlined, and the structure of the thesis presented.	
Chapter two	Provides more detail on how the research was conducted.	
Chapter three	Provides the comprehensive literature-based analysis using a wide variety of literature discourses and sources such as books, journals, planning and policy documents, and internet resources.	One
Chapter four	Describes the earthquake damage and provides the current political and legislative context in which the topic and the issue are situated.	
Chapter five	Presents the results of the participant interview analysis and links this with relevant literature-based commentary.	One
Chapter six	Presents the results of the evaluation of the redevelopment plans against the adapted urban design matrix.	One and two
Chapter seven	Presents barriers to implementing sustainable urban design, using literature and interview participants data as evidence.	Three
Chapter eight	Discusses the results and concludes the study. Research limitations and recommendations are outlined.	One, two and three
Appendices	Allow the reader a more in-depth view of the full research process undertaken, and include sample interview questions, copies of ethics approval, information sheet and consent form.	

1.5 Summary

Climate change is the most formidable challenge facing the world today and urban areas, due in part to CO₂ emissions from land transport, are a significant aspect of the problem. An opportunity has been presented in Christchurch to redevelop the central city following disaster using sustainable urban design to reduce car dependency and VKT and reduce associated CO₂ emissions. Research aims, objectives and questions have been designed to explore whether this opportunity will be seized by NZ's Central Government, who are overseeing the redevelopment. The next chapter will discuss the research design in more detail.

Chapter 2 Research design

This chapter explains the research process adopted for this study. These research methods were approved by the Victoria University of Wellington Human Ethics Committee prior to data collection occurring (ethics approval is attached as Appendix one).

The nature of the research problem allowed for a pragmatic approach to research to be undertaken. Pragmatism is concerned with actions, real-world situations, consequences, and practical activity and argues for research to address and solve problems (Creswell, 2003; Kitchin & Tate, 2000). Pragmatism allows for different forms of data collection and analysis, often termed a mixed methods approach (Creswell, 2003), which Hay (2005, p. 191) describes as 'a combination of techniques for tackling a research problem'. This type of approach was chosen for this research to synthesise primary data collected through semi-structured interviews with secondary data comprising official planning and policy documents.

2.1 Data collection: Interviews

Semi structured interviews are a commonly used method for obtaining qualitative data (Longhurst, 2010) and are often used to explore complicated or slowly evolving events or issues (Hoggart, Lees, & Davies, 2002). The redevelopment of the central city of Christchurch after a series of earthquakes in 2010 and 2011 can be categorised as complicated and slowly evolving. Prepared questions may be used (Dunn, 2005) although the interviews are 'conversational or informal in tone' (Longhurst, 2010, p. 105) and participants can explore issues that they feel are important. Although unrestricted in terms of question phrasing and order as in structured interviewing, the researcher can intervene when the conversation deviates from the intended research topic (Dunn, 2005). In-depth insights can emerge from this flexible technique which is useful for collecting and identifying complex behaviours, opinions, emotions, and diversity of experiences (Longhurst, 2010).

2.1.1 Participant selection and recruitment

The recruitment technique where one participant recommends another, termed snowball sampling (Bradshaw & Stratford, 2005; Cameron, 2005), was used in

participant recruitment. Participants were initially selected from a variety of organisations involved in the redevelopment of central Christchurch post-earthquakes including:

- officials from Local Government agencies;
- private planning and urban design professionals from leading consultancies;
- environmental and urban design academics; and
- officials from Central Government agencies.

Online resources were used to identify relevant organisations involved in urban design and planning within Christchurch and NZ as a whole. Authors of key documents related to urban design and the redevelopment of Christchurch were initially identified as suitable participants. These participants were contacted, interviewed, and asked whether they could identify further interview candidates suitable to the research and who may wish to be involved. The remainder of participants were identified in this manner (i.e., snowball sampling). A total of 13 participants were interviewed over 12 separate interviews. One interview was attended by two participants; they are referred to as interview 8a and 8b in the text. A full list of interview participants is provided as table 2.1, below.

Table 2.1: Interview participant details

Interview participant	Role
1	Local Government Official
2	Local Government Official
3	Local Government Official
4	Local Government Official
5	Local Government Official
6	Local Government Official
7	Central Government Official
8a	Central Government Official
8b	Central Government Official
9	Central Government Official
10	Urban design professional
11	Academic
12	Academic

2.1.2 Conducting interviews

The primary data for this research has been collected via semi-structured face to face interviews. The purpose of conducting the interviews was to canvass a range of participants involved in the redevelopment to gain perspectives on current best practice, future opportunities, and barriers to achieving sustainable urban design. A set of initial basic questions were developed prior to interviewing each participant (attached as Appendix two), and additional information was retrieved as the interview developed and additional questions emerged spontaneously. The participants were able to provide as much information as they deemed necessary, however the interviewer was able to steer the conversation in the relevant direction.

The interviews lasted approximately one hour, and the participants were provided with an information and consent form (attached as Appendix three and Appendix four respectively) to read and sign prior to the interview. These forms informed each participant of data storage, protection of privacy, and interview rules such as withdrawal of participation. In line with University of Victoria policy, any research involving human subjects requires human ethics approval from the University's ethics committee. The author and proposed research design was subject to a robust and thorough ethics process and obtained ethics approval from the ethics committee on 11 April 2012.

2.2 Literature and document analysis

A comprehensive literature-based analysis was performed to gain an understanding of what constituted contemporary sustainable urban design. This analysis used a wide variety of literature from many disciplines including urban design, spatial planning, transport, urbanism, environmental management and policy, and disaster recovery. International research, case studies and practical examples were examined and compared to those from NZ. Once a sound grounding in general variables of sustainable urban design was attained, further analysis of literature was conducted to focus on those urban design variables that could reduce CO₂ emissions from land transport. International disaster redevelopment narratives

were compared to the Christchurch scenario to ascertain what can be learned from previous, recent disasters in similar contexts.

Additionally, important national and regional level planning and policy documents were sourced and analysed to identify practice and strategy in NZ prior to the earthquakes and to compare and contrast these with post-earthquake recovery and redevelopment documents. These documents are listed in table 2.2, below.

Table 2.2: Important pre and post-earthquakes planning and policy documents

Planning and policy documents
The NZ Urban Design Protocol 2007
The Greater Christchurch Travel Demand Strategy and Action Plan (2009)
The Greater Christchurch Urban Development Strategy (2007, updated 2010)
Christchurch City Council Climate Smart Strategy 2010-2025 (2010)
The Christchurch City Council draft central city recovery plans for Ministerial approval (2011)
The Canterbury Regional Land Transport Strategy 2012-2042 (2012)
The Canterbury Earthquake Recovery Authority central city recovery plans (Blueprint plans)(2012)

An urban design matrix, adapted and updated from Thompson-Fawcett and Bond (2003), was used to provide an evaluation tool to determine whether the redevelopment plans for Christchurch will meet current international best practice in sustainable urban design. The adapted urban design matrix identifies a set of criteria to establish what can be considered best practice sustainable urban design to reduce CO₂ emissions from land transport. The urban design matrix has been adapted to contain only those criteria relevant to reducing CO₂ emissions from land transport, which included mainly criteria based on the physical built form of a site rather than economic or social criteria. The Central Government's Blueprint plans were then evaluated against these criteria to identify whether the redevelopment plans will be effective in reducing CO₂ emissions from land transport. This was then compared and contrasted with results for the Christchurch City Council's (CCC) draft central city redevelopment plans to highlight distinctions between them.

2.3 Data analysis

A thematic analysis technique was used to analyse the qualitative data obtained from interviewing participants. This technique allows large amounts of raw data to be reduced and grouped into common themes of manageable size (Bryman, 2008), and allows better consideration of how the data is related and presented. Important participant quotes are easily identifiable and available when validating key findings from literature, and patterns within the data are easily observable (Braun & Clarke, 2006). This analysis technique worked well as part of the mixed methods approach applied to this research, and was ideal for analysing the data from a variety of sources (i.e., literature, planning and policy documents, and interviews).

2.4 Summary

The nature of the problem that this research addresses allows for a pragmatic approach to be undertaken. Under pragmatism, a mixed methods approach was justified and was designed to best research how sustainable urban design will feature in the redevelopment of the central city of Christchurch to reduce CO₂ emissions from land transport. This approach involved data collection through a comprehensive literature analysis across relevant disciplines to gauge international best practice, a planning and policy document analysis to understand the NZ situation, and semi-structured interviews to gain perspectives on the topics from experts and decision-makers. An evaluation tool was used to assess the Government's redevelopment plans and provide useful evidence to combine with participant interview data. This data was grouped into themes to assist analysis and helped to synthesise this material with results obtained from the comprehensive literature analysis, which are discussed in the following chapter.

Chapter 3 Results of literature analysis

In this chapter, discussion will focus on the history of the concept of environmental sustainability, and outline how sustainable urban design evolved into practice. The issue of reducing car dependency through the adoption of variables of sustainable urban design to reduce CO₂ emissions from land transport, will also be discussed. The variables of increased density, mixed-use development, street layout and city design, and the provision of sustainable public transport are highlighted as academics and urban design practitioners have regularly noted their importance, including Cervero and Kockelman (1997), Ewing et al. (2008), and McKibben (2011). International best practice examples will be highlighted and compared with examples from NZ.

3.1 Context: Environmental and urban sustainability

During the 1960s environmental consciousness was developing through writers such as Carson (1962), and the modern day concept of environmental sustainability was emerging on the international political landscape, as evidenced by the United Nations (UN) Stockholm conference in 1972. This conference recommended action on international environmental issues, including climate change, and raised concerns of the environmental impact of urban space (Jackson, 2007). Global political action on environmental issues and sustainability continued in 1983 when the UN established the World Commission on Environment and Development (WCED) that published *Our Common Future* (1987), a report that launched the term 'sustainable development' into the modern lexicon. *Our Common Future* famously describes sustainable development as development that 'meets the needs of the present without compromising the ability of future generations to meet their own needs' (WCED, 1987, p. 8).

The UN Earth Summit conference in Rio De Janiero in 1992 further encouraged global environmental thought including a focus on climate change, transportation, and urban issues. This important event was followed by additional international conferences and summits specifically concentrating on cities and urban spaces as important places to focus efforts of sustainability, such as the UN Habitat II forum (Istanbul, 1996), the World Summit on Sustainable Development (Johannesburg,

2002), and the World Urban Forum 3 (Vancouver, 2006). Although the urban focus of sustainability has only emerged recently, these urban international forums are 'major vehicle[s] for the pursuit of sustainability' (Holden et al., 2008, p. 305), while cities are 'crucibles of innovation, where strategies can be catalysed to promote reductions in greenhouse gas emissions' (United Nations Human Settlement Programme, 2011, p. 1), and are 'our best hope for a more sustainable future' (Beatley, 2009, p. 20).

Beatley's comment above, reflects the reason for the increasing amount of literature focussing on urban sustainability, including articles and books by famous architects, urban designers, and academics such as Beatley (2009), Calthorpe (1993; 2002; 2011), Cervero (1998), Duany et al. (2000), Ewing et al. (2008), and Newman and Kenworthy (1989; 1999). This increase in literature has been reinforced by urban practitioners as planning, architecture and urban design professionals have increasingly become involved in the discussion and implementation of sustainable urban theories into real world examples. Many cities internationally have implemented best practice sustainable urban design into city plans and into their urban space, including Seattle, Copenhagen, and San Francisco. Melbourne and Adelaide have set urban growth boundaries, Portland has restricted roading growth and implemented light rail transit, and London charges a fee for driving into the inner city to influence travel behaviour, and to reduce congestion and pollution (Newman, 2004). Despite these efforts not one city has been able to create a comprehensive policy package of economic and behaviour change incentives, combined with spatial planning techniques, such as urban growth boundaries, re-urbanisation and sustainable transport to deliver a truly sustainable city (Newman, 2004). This reflects the political risk associated with implementing such measures, which Newman (2004) believes is necessary in order to create gains towards sustainability. This point is re-iterated by Banister (2011) who questions whether there is the commitment and leadership to follow opportunities for innovative, low-carbon transport futures.

Attempts at urban sustainability are now focussing on how the design of urban space can reduce dependency on the private car for transport which is considered a major factor contributing to CO₂ emissions and climate change.

3.2 Reducing car dependency

“The car has allowed us to spread out but often only to do the things that we used to do by walking” (Carmona et al., 2010, p. 37).

Any urban design approach to reduce CO₂ emissions from land transport must include strategies and incentives to reduce the populations’ need to use the private car for transport and reduce car dependency. Since the 1950s cities have sprawled rapidly, due to the increased mobility offered by the car. This has affected the way planners organise our cities and patterns of urban form, leading to increasingly car-dependent cities and nations (Carmona et al., 2010; Duany et al., 2000). Furthermore, global environmental issues such as climate change are exacerbated, while other environmental costs, as well as social and economic costs, can also result, as highlighted in table 3.1, below.

Table 3.1: Environmental, social and economic costs of car dependency

Type of costs	Detail
Environmental costs	Oil vulnerability, petro-chemical smog, toxic emissions such as lead and butane, high greenhouse gas emissions, loss of land through urban sprawl, greater storm water problems from extra hard surfaces, and traffic problems such as noise.
Social costs	Loss of community and street life, loss of public safety, access problems, suburb isolation and severance (the splitting of communities by physical impediments such as highways).
Economic costs	Congestion costs, loss of rural land, external costs from accidents and pollution.

Source: Newman and Kenworthy (1999).

As a result of car-dependant urban patterns, the need for public transport has diminished, thereby alienating those residents without cars (Lohan, 2001, cited in Carmona et al., 2010), and/or those who cannot drive such as the elderly, the youth, and the disabled. Social equity and social isolation issues are also

exacerbated as these groups are not able to access key facilities and services easily. (Haughton & Hunter, 1994).

The economic costs of car dependency are identifiable in California, where land transportation is responsible for 38 per cent of greenhouse gas emissions and associated costs including those related to traffic congestion (Cervero & Murakami, 2010). Congestion costs USD\$2.8 billion every year in excess fuel consumption and lost productivity in the USA (Legislative Analyst's Office, 2000, cited in Cervero, 2003).

Car dependency is often measured by the distance travelled in cars by a population, or Vehicle Kilometres Travelled (VKT). VKT per person is considered a major factor correlating with environmental degradation and resource consumption in the transport sector (Cervero & Murakami, 2010). Local and global pollution in the form of particulate matter and greenhouse gases increase as VKT increases, as does the consumption of resources such as fossil fuels and open space (Cervero & Murakami, 2010). Cervero and Murakami's (2010) study of the effects of the built environment on 370 urbanised areas in the USA shows that the design of urban space has a significant effect on VKT. In turn, this means urban design can reduce CO₂ emissions and fossil fuel consumption. Research from the Center for Climate Change in Washington D.C. shows that even substantial technology advances in fuel efficiency and low carbon fuels cannot reverse the trend of rising per capita emissions without a significant reduction in VKT per person (Condon, 2008, cited in Cervero & Murakami, 2010; Ewing et al., 2008). Cervero and Murakami (2010) suggest that urban design and other 'demand-side' strategies to reduce VKT, such as carbon and congestion pricing, should be used in conjunction with 'supply-side' strategies, such as low-emission fuels and vehicles, to reduce VKT and reduce CO₂ emissions from land transport.

In order to overcome car dependency and reduce the associated environmental, social and economic effects, a comprehensive suite of planning and policy initiatives is required, as shown in table 3.2, below.

Table 3.2: Policies needed to overcome automobile dependency

Policies needed to overcome automobile dependence	
Physical policy	<ul style="list-style-type: none">• Expand transit, particularly rail• Increase density, particularly at transit stops• Mix land use• Calm traffic• Emphasise redevelopment over new development at fringe• Build pedestrian and cycle infrastructure
Economic policy	<ul style="list-style-type: none">• Remove subsidies on all transport costs, especially parking• Remove subsidies on fringe development• Establish carbon tax on fossil fuels
Social policy	<ul style="list-style-type: none">• Provide public education on good cities• Ensure participation on strategic planning especially balance of transit vs. cars• Establish demonstration transit-oriented urban villages of high quality, dense housing with good public spaces• Improve attractiveness of city centres

Source: Newman (1995).

Table 3.2 demonstrates some of the planning and policy initiatives required in the redevelopment of the central city of Christchurch in order to reduce car dependency and associated CO₂ emissions. Unfortunately these planning and policy initiatives have not been common in NZ's urban development to date. Urban design is one element of city planning that can assist in creating more sustainable urban spaces and reduce the population's dependency on the private car and reduce the associated environmental effects such as CO₂ emissions, and is discussed in the following section.

3.3 What is urban design?

Urban design is a process that has developed out of the disciplines of town planning, architecture, environmental management, and social science (Bentley & Butina, 1991, cited in Carmona et al., 2010; Gosling & Maitland, 1984), and can simply be described as 'the process of making better places for people than would otherwise be produced' (Carmona et al., 2010, p. 3).

Urban design began to emerge from the town planning discipline in the late 19th century when Sitte (1889) and later Unwin (1909) began concentrating on visual and aesthetic qualities of urban spaces (Carmona et al., 2010). Following from these authors and focussing on the undesirable elements of industrialisation such as unhealthy, cramped cities due to rapid urban growth, Ebenezer Howard created visions of how better urban living could be achieved through planning and design, by describing plans of small towns complete with transport nodes and green belts in his seminal work, *Garden Cities of To-morrow* (1902). Lewis Mumford (1938) was another urban visionary who became critical of the lack of planning and design of urban form.

However it was not until the 1960s that the social usage tradition of urban design began to materialise through the thinking of influential writers and designers such as Kevin Lynch (1960), Jane Jacobs (1961), and Jan Gehl (1971) (Carmona et al., 2010). This tradition focussed on the way that people used urban space and was concerned with the socio-functional aspects of urban features as places of social interaction (Carmona et al., 2010). These important traditions have led to the more recent concepts including sustainable urban design.

3.4 What is sustainable urban design?

Sustainable urban design is becoming an increasingly important part of the disciplines of planning, architecture, and urban design, and has gained so much traction recently that it has been described as ‘a major new paradigm in planning’ (Beatley, 2009, p. 17). Sustainable urban design follows on from urban design traditions which have concentrated on the need for more human-centred urban spaces that can offer increased quality of life locally while mitigating the unwanted global environmental consequences of urban living (Carmona et al., 2010).

Sustainable urban design became apparent as a practical element of urban design in the 1980s. In *Towards an Urban Design Manifesto*, Jacobs and Appleyard (1987) list prerequisites of good urban environments in the future which include minimum density guidelines and the integration and proximity of activities. Tibbalds (1992)

also developed an urban design framework which encourages pedestrian freedom and the mixing of land uses and activity types.

Concerns relating to the environmental effect of land transport led to authors such as Newman and Kenworthy (1989; 1999) highlighting issues including the rising energy consumption from urban areas, rising CO₂ emissions, and increased air pollution. Newman and Kenworthy (1989) mapped the correlation between urban density and private transport energy use per capita, showing a distinct relationship between high density and low energy use, and argue that three characteristics control petroleum use in urban areas; population density, job density, and city centre dominance. This has led to more recent literature, including Berman (1996), Ewing et al. (2008), and Calthorpe (2011), that focuses on characteristics of urban development that can mitigate negative environmental consequences such as increased CO₂ emissions from land transport through reducing a population's dependency on the car. The characteristics displayed by car-dependent and non car-dependent urban areas are outlined in table 3.3, below.

Table 3.3: Characteristics of car-dependent and non car-dependent cities

Characteristics of cities	
Car-dependent	Non car-dependent
Road dominated	Balanced transport
Minimal public transport	Strong supply of public transport
Minimal uptake of alternative modes	Walking and cycling provided for
Walking and cycling not provided for	Higher density, with a range of housing types and smaller sections
Low density	Compact
Sprawled	Centrally concentrated development or development at transit nodes
Segregated land uses	Mixed land uses, including mixed-use core within walking distance for residents

Cul-de-sac style street network	Grid street patterns that provide multiple paths for drivers and pedestrians
One-way streets	Many pedestrian and cycle entry and exit points to the central city
Little pedestrian connectivity	Narrow streets with sidewalks
Aesthetically challenged	Aesthetically pleasing
Decentralised	Local employment and civic centres

Source: Berman (1996)

These characteristics are re-iterated by Ewing et al. (2008, p. 1) who use the term “compact development” to describe places of higher average densities, as well as featuring ‘a mix of land uses, development of strong population and employment centers, interconnection of streets, and the design of structures and spaces at a human scale’. Their research suggests that if 60 to 90 per cent of all new developments in the USA were compact development it would result in a reduction of VKT by 30 per cent and a corresponding reduction of CO₂ emissions from land transport of 7 to 10 per cent by 2050. Chapman (2008) believes that NZ could make similar, but smaller, reductions. Hankey and Marshall (2010, p. 4886) also suggest ‘zoning for mixed-use and for transport corridors, removing building height restrictions (or adding flexibility), raising density maximums, and reducing or eliminating minimum parking regulations’ to encourage compact growth.

These land use policies and research show that increasing density, mixed-use development, street layout and city design, and the provision of sustainable public transport are important variables in sustainable urban design to reduce CO₂ emissions from land transport. They will be further described in the following section.

3.5 Variables of urban design to reduce CO₂ emissions from land transport

Research into the effect of variables of urban design was initially conducted by Cervero and Kockelman (1997). Their research focuses on three variables, density, diversity (i.e., mixed-use development), and design (i.e., street layout and city

design), and showed that these particular characteristics of the urban area surrounding a household affected CO₂ emissions generated by that household through affecting the number of vehicle trips and VKT (Cervero & Kockelman, 1997; Lee & Cervero, 2007). Subsequent research has expanded the variables to incorporate the effects of the provision of sustainable public transport, and labelled these destination accessibility and distance to transit (see Ewing et al., 2008; McKibbin, 2011).

These variables can be described as:

- 'density– how many residents and/or employees are located within a unit of area (such as hectares), indicating potential trip origins and destinations;
- land use diversity– the degree to which different land uses are located within close proximity of each other, reducing the need to travel outside of the area for common trip purposes;
- pedestrian-oriented design– a range of measures which describe how conducive an area is to walking, variously described by the quality of footpaths and road crossings, the connectivity of the road network, and the quality of the pedestrian environment (noise, safety, visual interest, weather protection);
- destination accessibility– reflecting the proximity or ease of access to regional trip opportunities such as employment, which can be measured by distance or time; and
- distance to transit– how far an area is from the nearest public transport stop or station' (McKibbin, 2011, p. 3).

Following Cervero and Kockelman (1997), many authors have described the urban design variables in different ways but have stressed their importance as techniques to reduce CO₂ emissions from land transport (for example, Ewing et al., 2008; Lawrence Frank and Company, 2008; McKibbin, 2011; the United Nations Human Settlement Programme, 2011; Walters & Ewing, 2009) as they can assist in reducing automobile dependency and a population's VKT. Ewing and Cervero (2001) summarised the results of 14 studies relating to travel and the urban design variables. This research found that increased density, mixed-use development, and

street layout and city design resulted in a reduction of both the number of vehicle trips, as well as VKT. Leck (2006) reviewed 40 published studies relating to the travel and the built environment, and found that density, mixed-use development, and street layout and city design had a statistically significant negative impact on VKT. These and other studies, have established these variables as influential on CO₂ emissions from land transport, and therefore they have been selected as the focus of this study.

The variables of destination accessibility and distance to transit, as described above, cannot be applied effectively to this research due to the focus on the central city of Christchurch, rather than the interactions between the central city and the wider metropolitan area. Nevertheless these variables do contain important elements of sustainable urban design, namely the provision of sustainable public transport. Therefore this variable has also been included in this research due to its effectiveness in reducing CO₂ emissions from land transport. Other research that considers the provision of sustainable public transport to be important include Cervero (1984), Newman and Kenworthy (1999), and Newman, Beatley, and Boyer (2009).

Thus, four key elements of sustainable urban design that can reduce car dependency and consequently reduce CO₂ emissions from land transport selected for this research are; increased density, mixed-use development, street layout and city design, and the provision of sustainable public transport. These variables are discussed at length in the next sections of this chapter.

3.6 Increased density

Density can be described as the 'concentration of population and activity in an urban area' (McIndoe et al., 2005, p. 3). Due to close residential population proximity to key destinations such as workplaces, schools, retail outlets, recreational and cultural facilities, and proximity to essential services such as transportation (ECOTEC, 1993; Ewing et al., 2008), CO₂ emissions from land transport can be diminished by reducing the need to travel by private car. If people live near to these essential destinations and services then they are more likely to

gain access using alternative non-polluting modes, such as walking or cycling. If they do require a car to reach their destination, the journey will be short (ECOTEC, 1993; Ewing et al., 2008). Newman and Kenworthy (1999, p. 100) state that 'density patterns are closely linked to transportation' and literature suggests that public transport also becomes more viable at higher densities (Abrahamse & Witten, 2011; ECOTEC, 1993; Grazi et al., 2008; Newman, 2006); therefore a range of public transport options may be accessible and more convenient than using a private car, as time and costs increase through traffic congestion, tolls, and limited parking. These reasons suggest that increased density is possibly the most important urban design variable, as the other variables in isolation cannot provide the same reductions in CO₂ emissions. The effect of increasing density has therefore been more widely studied than the other variables, which is reflected in this literature analysis.

Urban form has been affected by the use of oil as an energy source for transport, which has allowed cities that have developed in the automobile era to be more sprawled and of lower density than older cities (United Nations Human Settlements Programme, 2009). In the past urban densities were higher as the convenience of automobile transport was not available. In the Georgian era in the UK (between the years 1714-1830) urban density averaged 100-200 dwellings per ha, compared to a typical density in the UK of 23 dwellings per ha, and typical USA density of 18 dwellings per ha in current times. (Banister, 2005). Planners in the past have attempted to nominate an ideal density figure. Howard (1902) recommends a density of 45 dwellings per ha in his Garden City, while more recent literature with an environmental focus calls for 69 dwellings per ha (Rudlin, 1998).

Newman and Kenworthy have produced several studies (1989; 1999; 2006) that suggest that compact, dense urban areas have less automobile use, greater use of alternative transportation modes, and generate shorter automobile trips relative to sprawled urban areas. Newman and Kenworthy's influential work *Cities and Automobile Dependence* (1989) demonstrates the link between private transport energy use per capita and urban density, and shows how increased density correlates to less energy use per person (see figure 3.1, below). Their study showed

a strong increase in petroleum consumption in cities with densities of less than 29 persons per ha. This has been reinforced by Holtzclaw et al. (2002), while other studies show that car-dependent land use patterns appear as a common characteristic in those cities below 20-30 persons per ha (Naess, 1993; Newman & Kenworthy, 1989). This is further reinforced by Newman and Kenworthy (2006), who suggest that population density of over 35 persons and jobs per ha is the key threshold beyond which car dependence is significantly reduced.

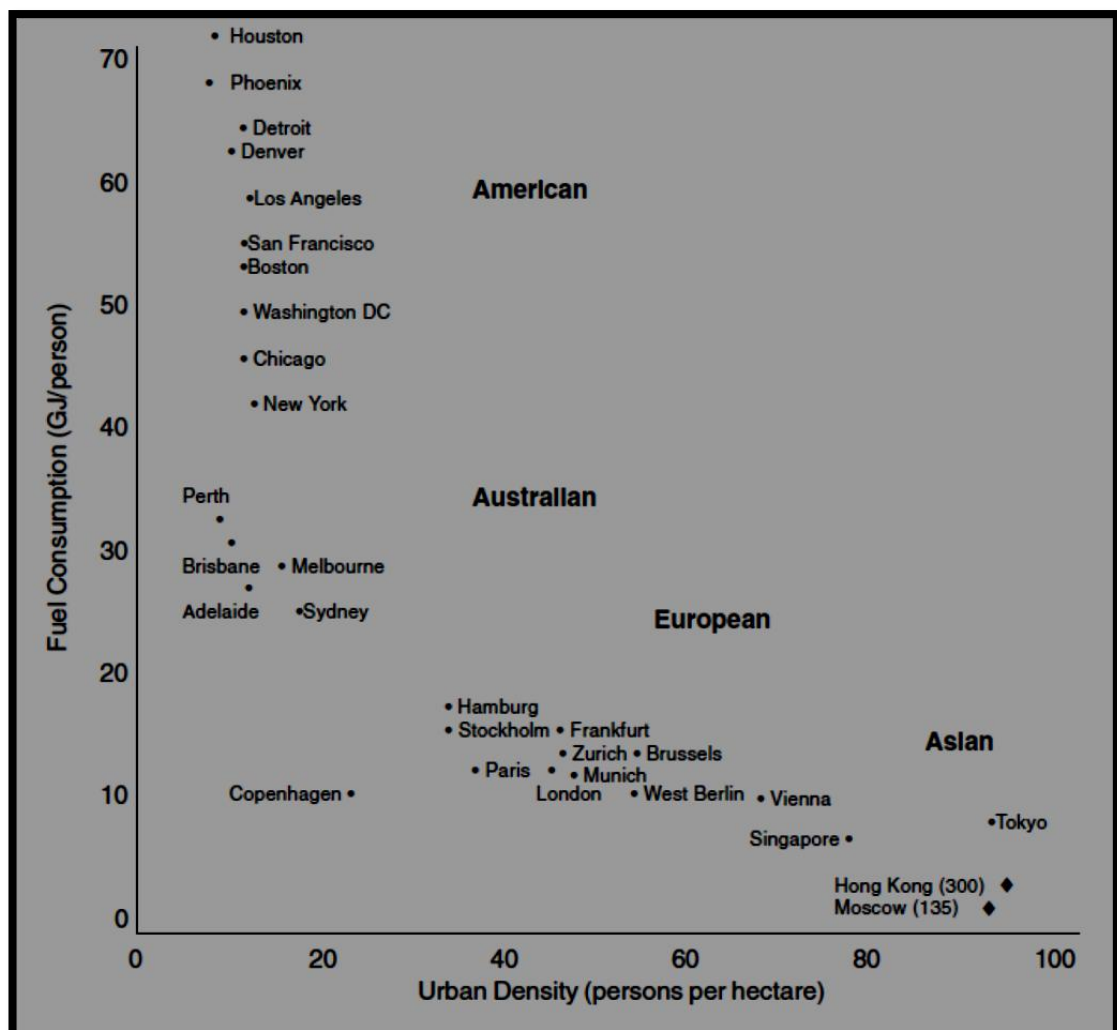


Figure 3.1: Relationship between density and gasoline use per capita in 1980. Source: Newman and Kenworthy (1989), cited in Newman (1996).

Figure 3.1 shows significant differences in density between European and American cities. Bruegmann (2005) reports that European and American urban development diverged post world war two as sprawl dominated in the USA while planners were

able to exert more influence in Europe due to the critical need for rebuilding. This can also be seen in figure 3.2, below, which shows older European and Asian cities achieving higher population densities than newer American and NZ cities.

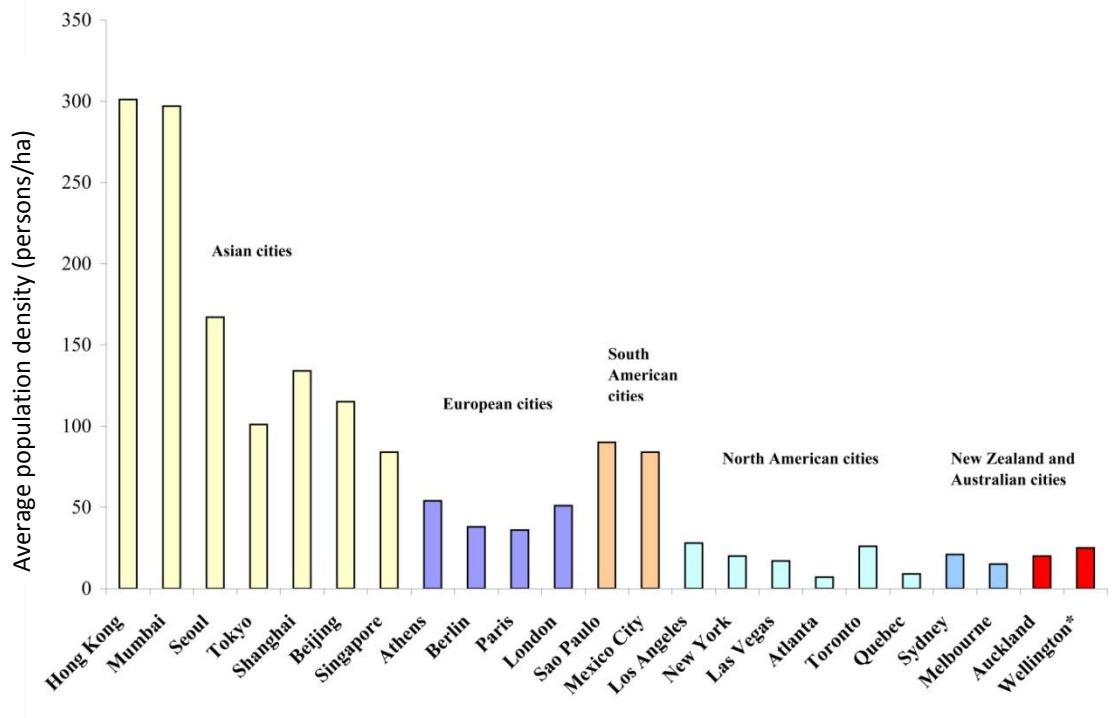


Figure 3.2: Average population densities in urban area of selected cities (persons/ha). Source: Zhao, Chapman, & Howden-Chapman (2011).

Newman and Kenworthy (1999) also show evidence to prove that people living in higher density cities have shorter commuting distances to work, and are more likely to travel to work by walking or cycling. Furthermore, Newman and Kenworthy (1999) show a correlation between the concentration of development in the central city and reduced distances travelled, as well as a reduced proportion of trips by private automobile due to an increased choice in mode of travel. Increasing the distance from home to the city centre results in increased travelling distance, increased number of car journeys, and increased transport energy consumption (Banister, 2005; ECOTEC, 1993; Hillman & Whalley, 1983).

Brown, Southworth, & Sarzynski (2008) provide evidence to show that the cities whose populations are the lowest emitters per capita are also the most dense cities in the USA (e.g., New York, Los Angeles). Those USA urban areas with the highest

per capita emissions were also found to be of the lowest in density (e.g., Atlanta, Nashville). Their research showed that the primary difference was the reduced amount of travel by private automobiles and a correlation can be found between density, concentration of development, use of rail transit and low per capita emissions. These results are shown in table 3.4, below.

Table 3.4: Per capita CO₂ emissions from auto transportation from selected US cities in 2005.

City	Metric tonnes of CO ₂ emissions per capita from auto transportation 2005	Density (persons per km ²)
New York	0.664	1800
Chicago	0.820	1300
Portland	0.860	1400
Los Angeles	0.882	2400
Atlanta	1.224	700
Nashville	1.319	700
Oklahoma City	1.320	800

Source: Brown et al. (2008) and Demographia (2013).

These results are reinforced by Banister (2005), who found that in areas of low density (less than one person per ha), 72 per cent of all journeys were taken by private car. In areas of high density (more than 50 persons per ha), only 51 per cent of all journeys were taken by private car.

Brown et al. (2008) highlight how low-density development reinforces auto-dependency by undermining efforts to support alternative modes of travel, such as walking, cycling, and public transport. Newman and Kenworthy (1999) reinforce this by suggesting that increases in density are best realised by being focussed on nodes (connecting points or intersections) along transport corridors. These sentiments are echoed by the tenets of the transit-oriented development approach, as advocated by Calthorpe (1993).

However the relationship between transport and urban form in general is complex and widely debated. It is difficult to define cities as achieving one type of form (e.g., compact city form) as they are generally in a constant state of development and contain a mixture of densities (Banister, 2005). Critics, including Gomez-Ibanez (1991), and Gordon and Richardson (1989), argue that many other factors can determine car use including culture, demographics, availability of public transport, and income. Therefore low car use may not necessarily be solely a function of compactness and density. However further studies on the relationship between urban form and VKT such as Cameron, Kenworthy, & Lyons (2003; 2004) and van de Coevering and Schwanen (2006) found that even when controlling other factors, urban form, such as high density, has a significant effect on VKT.

3.6.1 Sprawl

The antithesis of a dense and compact city is the phenomenon of sprawl. Bruegmann (2005, p. 18) defines sprawl as 'low density, scattered, urban development without systematic large-scale or regional public land-use planning', and discusses how sprawl is a complex pattern of urban development that has featured in cities throughout history, usually accompanied with an increase in affluence, but has only become a mass phenomenon in the twentieth century. Urban sprawl is characterised by low density, large geographical spread, separation of land uses and activities through zoning as a planning technique, increased roading infrastructure (e.g., motorways) and associated costs (e.g., road building costs, collision and injury/mortality costs), and increased dependence on private car for transport (Saville-Smith, 1999).

In order to measure sprawl, Galster et al. (2001) used eight characteristics of urban areas (density, continuity, concentration, clustering, centrality, nuclearity, mixed-use, and proximity). Similar work by Ewing, Pendall, and Chen (2002) measured sprawl in 83 urban areas in the USA. Their results found that as sprawl decreased:

- daily VKT per capita decreased;
- work trips on public transport increased;

- work trips by walking increased;
- average vehicle ownership decreased; and
- annual traffic fatality rate decreased.

These results are mirrored by Hankey and Marshall (2010), who studied statistics from 142 urban areas in the USA and developed six different scenarios of US urban growth ranging between high and low level sprawl. Their results showed that high level compact development could reduce cumulative emissions in the USA by 15 to 20 per cent (up to 3.2 Gt CO₂-e). Any compact development or changes to urban form to reduce VKT should be supported by other approaches, such as fuel efficient vehicles and low emission fuels, as without the support of these complementary approaches, gains achieved through improved urban form may be undermined (Ewing et al., 2008; Hankey & Marshall, 2010). Hankey and Marshall (2010) conclude that urban form and design can affect travel mode choice and distance, and dense and compact urban areas result in less car dependence and less transportation energy consumption per capita than low density urban areas. This shows that emissions by residents can 'differ by city design, type and geographic location' (Hankey & Marshall, 2010, p. 4880).

Similarly, Ewing et al. (2002) found that the populations of the ten least sprawling urban areas in the USA drove on average six miles (approximately 9.6km) less per day than the populations of the ten most sprawling urban areas. Considering the number of people involved this is a significant reduction. For example, Atlanta is one of the most sprawled cities in the USA and each resident drives more than 30 miles (approximately 48.3km) per day, while in Portland, one of the most compact cities in the USA, each resident drives less than 24 miles (approximately 38.6km) per day (Ewing et al., 2002). One characteristic of sprawled cities is increased roading infrastructure, commonly used to decrease traffic congestion. However, research shows that this is misguided due to the induced traffic effect.

3.6.2 Induced traffic

Induced traffic is the concept that increased roading capacity will only result in increased, rather than decreased, congestion. This suggests extra roading is a cause of urban growth and sprawl, not a response to them. Initially extra motorists are attracted to the decongestion provided by new roading and other travellers using alternative modes. These extra motorists soon leads to more congestion and VKT beyond that experienced pre-expansion (Ewing et al., 2008). Bruegmann (2005) argues that further roading and an associated increase in driving increases congestion and pollution; these important elements can increase a person's desire to move further from the city centre thereby exacerbating the phenomenon of sprawl.

Ewing et al. (2008) have confirmed this effect by analysing data contained in the Texas Transportation Institute's (TTI) urban mobility database. For the 2005 year the results indicate that, if other factors are constant, a ten per cent increase in highway lane miles would result in a 4.63 per cent increase in VKT. Therefore extra roading does not provide a long term solution to congestion, reducing automobile dependency, or reducing CO₂ emissions from land transport as it encourages driving and results in increased VKT. These findings establish the importance of providing a well-balanced transport system within cities, and further promote the opportunities that the Christchurch redevelopment offers in terms of reducing CO₂ emissions from land transport. Complementary to the notion of increased density another opportunity within the redevelopment of Christchurch is mixed-use development.

3.7 Mixed-use development

Ewing et al. (2008) describe mixed-use development as relating to the balance of land use mix of an area. Land use may be mixed between development types (i.e., residential, commercial, retail, industrial), and a balance may be achieved in terms of land area, floor area, or employment within sectors. Mixed-use development may occur at the building scale, the city block scale, or even at a neighbourhood scale. At a building scale mixed-use development may be practically implemented through having retail space on the ground floor, commercial (e.g., office) space above, with residential space on upper floors (Thorne, Filmer-Sankey, & Alexander,

2009). Maximising diversity has been described as 'the most significant planning principle' by Newman (1995, p. 259).

Mixed-use development is mentioned throughout urban design literature historically including in Tibbalds (1992), Congress for the New Urbanism (1993), and Duany et al. (2000). Mixing of land uses and activities is mentioned in urban design literature as a method to achieve sustainability or a 'sound urban environment' by Jacobs and Appleyard (1987, p. 117), who label the integration of activities, including living, working and shopping, in 'reasonable proximity to each other' as 'essential to the future of a good urban environment'. Other authors have developed this trend by describing mixed-use as an integral part of future cities and the future of urban design (Carmona et al., 2010; Newman, 1995). Calthorpe (1993) mentions mixed-use development as a key component of transit-oriented development, while Brown et al. (2008) report that increased land use mix is associated with lower private automobile use, shorter distances travelled, and lower private automobile ownership. Studies by Frank and Pivo (1994); Cervero (1996); Cervero and Kockelman (1997) show that mixing land uses reduces travel by private car.

Mixing land uses reduces the physical separation between significant points and activities within cities and can affect trip frequency, VKT, and mode choice. Reducing the need to travel long distances minimises the use of the private car for travel (Banister, 2005; Cervero & Duncan, 2006) as alternative modes, such as walking and cycling, will be utilised more regularly due to shorter journey distances (Banister, 2005; Cervero & Murakami, 2010; Ewing et al., 2008;). Additional journeys, required if land uses are separated and zoned, can also be avoided if complementary destinations are conveniently located in close proximity to each other (Cervero & Duncan, 2006).

Research by Cervero (1996) found that locating retail and services in close proximity to residences can result in a reduction of VKT for shopping by 25 per cent. Furthermore, several mixed-use development studies have focussed on how access to local retail can affect shopping trips, including Handy (1993), and Ferrell (2004)

who found that residents in the San Francisco Bay area with high accessibility to local retail have reduced travel time and shorter total distances for shopping. Cervero (1996) found that if retail shops are located within approximately 90 metres from a person's home, then they are more likely to commute by public transport, walking or cycling. This distance appears crucial as beyond this Cervero (1996) notes that private car commuting is more likely. Similarly, Ewing (1996) found that a reduction of VKT of 15 per cent was possible by balancing employment and housing in an area. Several other studies have found that residents who lived in areas with well-balanced homes to employment ratios had lower average VKT (Frank & Pivo, 1994; Kasturi, Sun, & Wilmot, 1998), while residents who lived in areas with poor homes to employment ratios had higher VKT (Peng, 1997).

3.8 Street layout and city design

McKibben (2011, p. 3) describes street layout and city design as 'a range of measures which describe how conducive an area is to walking, variously described by the quality of footpaths and road crossings, the connectivity of the road network, and the quality of the pedestrian environment'. This variable can equally apply to cycling, and is treated as such in this research. Street layout and city design relates to street network characteristics such as street pattern (e.g., grid or curvilinear), pedestrian and cycling infrastructure, and site and street dimensions (Calthorpe, 1993; Cervero & Kockelman, 1997; Ewing et al., 2008; Girling & Kellett, 2005). On a more detailed level, practical examples may include block size, number of four-way intersections, footpath coverage, street widths, street furniture, pedestrian crossings, cycleways, and pedestrian only areas (Cervero & Kockelman, 1997; Ewing et al., 2008; Girling & Kellett, 2005). The development of cities in the automobile era has led to the layout of urban space being dominated by the private car to provide improved accessibility for that mode. This generally leads to poorer accessibility for pedestrians, cyclists, and public transport (Haughton & Hunter, 1994).

The design of an area can influence CO₂ emissions from land transport by encouraging walking and cycling through:

- increasing connectivity;

- providing a high standard of pedestrian and cycling infrastructure; and
- traffic calming.

3.8.1 Increased connectivity

The connectivity of an area is one of the key aspects of encouraging walking as an alternative mode of transport (Holtzclaw et al., 2002). Lawrence Frank and Company (2008, p. 24) describe connectivity as measuring ‘the degree of route directness between destinations’ and incorporates urban design elements such as the street pattern, pedestrian infrastructure (e.g., laneways), and ease of access around an area. Increased connectivity is a key component of sustainable urban design concepts such as TOD (Calthorpe, 1993).

A good example of how connectivity affects travel distance can be seen in figure 3.3, below. Points A and B are approximately the same distance apart in each photo. However, due to the street pattern, walking distance in the curvilinear street pattern is double that of the connected grid pattern street layout (Lawrence Frank and Company, 2008). Curvilinear street pattern is characterised by cul-de-sacs, dead-ends, and curving streets.



Figure 3.3: The difference in route directness for varying street patterns. Source: Lawrence Frank and Company (2008, p. 25).

Cervero and Kockelman (1997) found that residents living in areas with grid pattern connected street design averaged significantly less VKT than residents of areas with non-grid pattern street design. Lawrence Frank and Company (2008, p. 24) support this statement by explaining that connectivity ‘allows the use of interconnected

street network designs as a mitigation measure, including grid designs, alleys, small block networks, and pedestrian connections'. In addition to a grid street pattern, laneways also increase connectivity in urban areas. This will encourage residents to walk rather than travel by private car as it is more convenient, especially if the laneways are pedestrian only.

Cul-de-sac style street pattern is ubiquitous in low density suburbs stemming from post world war two planning that advocated the suburban dream of single-use residential areas of large houses and sections (Duany et al., 2000). More recently increased connectivity is being advocated, and cul-de-sac style blamed for social isolation and poor access for pedestrians (Haughton & Hunter, 1994). Examples of highly connected areas of environmentally conscious urban design are Hammarby Sjostad in Stockholm, Sweden, and Rieselfeld and Vauban in Freiburg, Germany (Cervero & Sullivan, 2011). These areas have consciously designed their urban space to reduce the need to travel by private car and have achieved significant reductions in CO₂ emissions per capita through a variety of urban design variables including increasing the connectivity of their street network. Laneways, calmed traffic, and grid pattern of streets have contributed to a 50 per cent reduction in transportation CO₂ emissions per capita in Hammarby Sjostad compared to other Stockholm communities (Cervero & Sullivan, 2011). Increasing connectivity through street pattern and laneways can encourage walking and cycling as modes of transport. Another method is providing pedestrian and cycling infrastructure.

3.8.2 Improving pedestrian and cycling infrastructure

Urban designers, authors, and planners have been concerned with creating urban spaces that are inherently more human, or spaces at a more human scale (Ancell & Thompson-Fawcett, 2008; Carmona et al., 2010; Newman & Kenworthy 1999; Ritchie, 2009), including creating spaces that are more walkable and cyclable. Newman and Kenworthy (1999; also Newman, 1995) argue that in order to overcome car dependence, policies to encourage walking and cycling are required, namely:

- traffic calming, such as reduced speed limits and street furniture, that slows car speed in urban areas to create safer and more pedestrian friendly spaces; and
- improved transit, bicycling and walking to provide realistic alternatives to private car travel.

Several authors agree that developing more walkable and cyclable urban areas will reduce VKT and will, by association, reduce GHG emissions (Calthorpe, 2011; Cervero & Murakami, 2010; Ewing et al., 2008). Examples of best practice for cycling infrastructure can be found in Copenhagen and Amsterdam, where approximately a quarter of all journeys are undertaken on bicycle, and Bogota, Colombia, which spent USD\$180 million on cycling infrastructure between 1990 and 2002 (Cervero et al., 2009).

Urban designers can address the practical requirements for pedestrians through good urban design techniques (Ritchie, 2009), such as multiple access routes into and around urban areas for pedestrians. To encourage walking as an alternative transport mode, urban designers and planners must create spaces that are suitable and attractive for people (Ritchie, 2009). Urban designers and planners can create these spaces by creating more pedestrian-only connections through urban areas, increasing the amenity value, and slowing traffic to increase pedestrian safety.

3.8.3 Traffic calming

Traffic calming is the process of slowing car traffic in order to develop urban space that is more people-oriented (Newman & Kenworthy, 1999). Traffic calming can involve the designing of streets or neighbourhoods to 'minimise the intrusion of road traffic' (Haughton & Hunter, 1994, p. 11) to encourage greater pedestrian and cyclist use. This may practically be achieved through prohibiting vehicles (pedestrianisation), building pedestrian access routes and cycleways, narrowing roads and road entrances, building chicanes and speed bumps, lowering speed limits, and introducing street furniture such as benches and trees (Haughton & Hunter, 1994).

Research shows that drivers reduce speed when street widths are narrowed and when features are placed adjoining the road (Girling & Kellett, 2005). These features may include tree plantings, benches, level footpaths, and lowered curbs (so the footpath is level with the road), and can result in increased priority for pedestrians, sharing of the road space, and increased walking trips (Duany et al., 2000). These streets become part of a city's sustainable transport network as pedestrians will favour these routes and use them to access destinations in the city rather than driving (United Nations Human Settlements Programme, 2009). As these streets attract an increased amount of foot traffic, they can also be attractive to businesses (United Nations Human Settlements Programme, 2009). Despite this, business owners often object to pedestrianisation as they perceive a loss of revenue if private car access is restricted (Haughton & Hunter, 1994). Research contradicts this perception however, as revenue has been shown to increase in most instances following pedestrianisation (Hass-Klau, 1993; Roberts, 1981; Whitehead, Simmonds, & Preston, 2006). Increased pedestrian safety, reduced CO₂ emissions, and increased business revenue can stem from city layout or design to encourage alternative modes of transport to the private car such as walking and cycling. This represents a positive opportunity within the redevelopment of Christchurch. Another opportunity, the provision of sustainable public transport, is explored in the following section.

3.9 Provision of sustainable public transport

Any suite of initiatives to reduce CO₂ emissions from land transport must offer alternative modes of travel so people can reduce their car dependency but are still able to access significant points across an area with ease. Sustainable public transport is a combination of public transport (e.g., buses, trains, trams, subways), and walking and cycling infrastructure and initiatives that contribute to the overall transportation system. Pedestrian and cycling infrastructure has been discussed in *street layout and city design* (refer section 3.8), above, so this section will focus on light rail transit (LRT).

The Centre for Sustainable Transportation, has described the key elements of a sustainable transportation system including:

- allows the basic access needs of individuals and societies to be met safely and in a manner consistent with human and ecosystem health;
- is affordable, operates efficiently, offers choice of transport mode, and supports a vibrant economy; and
- limits emissions and waste, minimizes consumption of non-renewable resources and minimizes the use of land and the production of noise (Gilbert et al., 2003, cited in Haghshenas & Vaziri, 2012).

Many cities internationally have embraced sustainable public transport in an effort to reduce CO₂ emissions, build resilience against climate change and car dependency, improve the health and well-being of the population and even reduce costs to the economy. Many cities in Europe, such as Amsterdam, have low emission public transport that has excellent uptake among citizens. Even cities in the developing world have turned to innovative sustainable transport initiatives, such as Curitiba, Brazil, that has an effective bus rapid transit system with high ridership rates (Cervero et al., 2009).

Many authors, such as Newman and Kenworthy (1999), Cervero (1998), Calthorpe (1993), and Banister (2005), have argued for changing a city's transport system towards more sustainable alternatives such as low-emission public transportation, and increasing uptake of public transport. Newman and Kenworthy (2001) have also shown that cities with significant sustainable transport spend less overall on transportation due to reduced costs of road construction and maintenance, better operating cost recovery and fuel efficiency, fewer road accidents, and less air pollution. Increased ridership of public transport provides greater gains in fuel efficiency than current technological improvements, as can be seen by Newman and Kenworthy's (2001) data comparing bus systems in cities across the globe. However, rail-based travel is the most fuel efficient motorised transport (Newman & Kenworthy, 2001). Brown et al. (2008) recommend that density coupled with investment in rail-based public transport can increase emission reductions per capita, which can be seen in Portland where there has been increased investment in light rail and reduced funding for roading (Beatley, 2009; Ewing et al., 2008; Newman & Kenworthy, 2001). Urban areas with high rail transit ridership also had

low per capita emissions values (Brown et al., 2008). Those cities that offer excellent transportation balance and extensive public transport emit less CO₂ per capita and are more resilient to the effects of climate change and resource scarcity (e.g., peak oil) (Newman et al., 2009).

Asian and European cities with high densities are leaders in this respect, as public transport accounts for a high proportion of all trips (Hong Kong 73 per cent, Tokyo 60 per cent, Singapore 40 per cent, Barcelona 35 per cent, Rome 35 per cent), while low density USA cities are dramatically behind in terms of public transport ridership (New York nine per cent, Atlanta and Denver one per cent) (Newman et al., 2009).

Cities, such as Vancouver, Canada, Portland and San Francisco, USA, Curitiba, Brazil, and Bogota, Colombia, are often cited as examples of how public transport can transform cities and reduce CO₂ emissions. Since the 1970s Vancouver has adopted an urban planning and transportation theory which centralises growth into the inner city and advocates compact, transit-oriented, walkable, bicycle-friendly land use, including mixed-use development (NZCID, 2010; So, 2008). Vancouver rejected sprawl and urban motorways and focussed development on the central city, which increased urban density and was supported by investment in sustainable, high-quality transport including the 'Skytrain', an elevated electric LRT (NZCID, 2010). Portland's "MAX" is another good example of how LRT can affect land use and drive development into corridors. Portland famously rejected federal highway funding and demolished an inner city bypass to create a waterfront park (Ewing et al., 2008). Bogota and Curitiba have used bus rapid transit systems to great effect to increase public transport ridership and to affect land use change along transport corridors; however they do not provide efficient long-term solutions and the development certainty along corridors and near stations due to emissions, noise and lack of permanence (Newman et al., 2009).

LRT can offer the long term certainty to encourage development and rail has a density inducing effect around stations, which is in part why LRT is being constructed in over 100 US cities (Newman et al., 2009). It is important when creating public transport, including LRT, that the speed is faster than private car

traffic to establish an advantage over driving which will encourage ridership and thereby reduce CO₂ emissions (Newman et al., 2009). Further reductions can occur when the electricity used to operate LRT is from renewable sources, which is likely in NZ. Unfortunately, as mentioned in section 1.3.1, NZ has been slow in enacting sustainable urban design initiatives (McIndoe et al., 2005; Saville-Smith, 1999). To understand why the next section will analyse NZ based research into sustainable urban design and discuss examples.

3.10 Sustainable urban design in NZ

“In NZ there has been little recognition and promotion of urban design principles that contribute to sustainability and improve the quality of life for urban people” (Parliamentary Commissioner for the Environment, 1998).

NZ towns and cities have developed in an era of cheap fossil fuels and increased mobility provided by the automobile, and to some extent resemble their American counterparts (Giradet, 2008; Keall, Chapman, & Howden-Chapman, 2010; Preval, Chapman, & Howden-Chapman, 2010), rather than older, denser European cities. This has affected the form of our urban space resulting in low density, decentralised, sprawled, highly suburban, road dominated towns and cities without efficient public transport systems (Auckland Regional Council, 2010; Giles-Corti, 2011; Giradet, 2008; Saville-Smith, 1999). Such development patterns have exacerbated private car use and led to a dependence on fossil fuels for transport purposes. Increased environmental problems, such as increased CO₂ emissions from transport, air quality issues, road surface run-off, and development of productive agricultural land, have emerged from this urban development and are not sustainable patterns for the future of urban areas in NZ or elsewhere (Saville-Smith, 1999). NZ’s emissions profile (refer section 1.2.1) clearly highlights the concerning trend of increased car dependence and associated increased VKT.

The NZ Government has been criticised for its lack of adequate response, funding, co-ordination of research and information provision for urban environmental issues (Hughes, 1999), and has only responded to the challenge of urban design issues in the recent past. NZ’s Parliamentary Commissioner for the Environment (PCE) first

investigated the urban environment in 1998 by releasing *The Cities and their People- New Zealand's Urban Environment*. This report recognised the need to focus on urban sustainability and the growing importance of urban areas as home to over 85 per cent of the population (PCE, 1998; Saville-Smith, 1999). The PCE (1998) noted that sustainable urban development had been largely ignored by NZ due to a lack of leadership, vision, and environmental strategies that inadequately address urban environmental issues. Other authors, such as Perkins et al. (1993) and Perkins and Thorns (1999), also criticise NZ's major planning legislation, the Resource Management Act (RMA), for not accounting for urban environment issues. The PCE (1998) report stressed the need to better integrate urban transport with environmental management and called for focussed strategies to reduce car-based transport including congestion pricing and improvements to public transport. The report explicitly asked for research to examine the relationship between urban form and vehicle emissions. It is concerning that little has been achieved in this area since this report was published 15 years ago.

Some research into sustainable urban design in NZ was conducted through the fifth Labour Government's now defunct sustainable development programme of action, which included the publishing of NZ's urban design protocol (the Protocol) in 2005. The Protocol is a voluntary commitment to urban design initiatives and signatories include city councils of all major towns in NZ (including Christchurch), property developers, and urban design professionals. The Protocol offers this definition of urban design:

'Urban design is concerned with the design of the buildings, places, spaces and networks that make up our towns and cities, and the ways people use them. It ranges in scale from a metropolitan region, city or town down to a street, public space or even a single building. Urban design is concerned not just with appearances and built form but with the environmental, economic, social and cultural consequences of design. It is an approach that draws together many different sectors and professions, and it includes both the process of decision-making as well as the outcomes of design' (MfE, 2005, p. 7).

The Protocol offered elements of quality urban design including those that relate to reducing CO₂ emissions from land transport, such as:

- allowing people to choose sustainable lifestyle options such as building type and mode of transport;
- encouraging mixed-use development;
- taking a long term view;
- placing high priority on walking, cycling and public transport;
- providing a sustainable choice of integrated transport modes;
- improving accessibility; and
- dependence on leadership at many levels to achieve a common vision over time.

The Government at the time supported the Protocol with a suite of supplementary resources including: Urban design case studies, *The Value of Urban Design* report, urban design toolkit and a summary of urban design research. *The Value of Urban Design* examined local and international literature and evidence on the merits of urban design to determine what practical benefits it could bring to NZ. This research examined wider aspects of urban design including environmental, social and economic benefits. The findings from this work determined that good urban design may cost more initially, but can provide significant community benefits, including positive environmental and health related benefits.

Further Central Government work on sustainable urban design in NZ emerged with the *Building Sustainable Urban Communities* report. It recognises the importance of building resilience to the challenge of climate change within cities in NZ and specifically highlights the need for less dependence on private automobile travel and suggests more mixed-use development should be provided for (DIA, 2008). MfE began work on a National Policy Statement for Urban Design, which included releasing a discussion document. Unfortunately a National Policy Statement did not eventuate, as a change in priorities (that did not include sustainability) resulted from the change of Government in 2008. These priorities are reflected in the 2011 Government Policy Statement on land transport funding which was released in July

2011 and forecasts transport infrastructure spending for a decade (2012-2022). This document has seven stated goals for transport infrastructure, none of which reflect the need to reduce emissions or adapt for a changing climate. In 2011/12, local roads and state highways were allocated \$2157 million, while public transport was allocated \$277 million, and walking and cycling only \$15 million (Ministry of Transport, 2011). The funding ranges for the next decade offer the same unbalanced mix of funding. Literature shows that the Government's policy to increase roading expenditure and capacity will not have the desired effect on travel times, and will not lead to a reduction in CO₂ emissions from land transport due to the induced traffic effect (refer section 3.6.2).

Unfortunately, research has noted that NZ needs an emphasis on climate change and sustainable infrastructure (NZCID, 2010). The NZ Council for Infrastructure Development (NZCID, 2010) produced a report comparing infrastructure development and planning processes in similar countries and regions to NZ, such as Sweden, Denmark, and British Columbia. The report recommended road user charging and road pricing to encourage a transport mode shift and reduce travel demand, as well as to fund new infrastructure. These recommendations are reinforced by the Danish architect and urban designer, Jan Gehl, who has promoted the virtues of walkable urban landscapes. His consultancy, Gehl Architects, was contracted by the CCC prior to the earthquakes in 2009 to conduct a study on the central city of Christchurch titled *Public Space Public Life*. In this study Gehl Architects assess the quality of Christchurch's urban space and how it may be used and developed to be more effective in creating a liveable and vibrant city that is more people focussed. The recommendations of this report include giving priority to pedestrians, cyclists, and public transport in the central city (Gehl Architects, 2009).

Recently in NZ, residential intensification has become a controversial catch phrase and has been used to describe urban development that promotes the virtues of sustainable urban design such as density, mixed-use development, street layout and city design, and the provision of sustainable public transport. Results in NZ have been inconsistent (van Bohemen, 2011) although successful examples such as

Talbot Park, Auckland, and Anzac Street West precinct, Auckland, are emerging (Scott, 2011). Another example is Botany Town Centre in south-east Auckland, which was studied by Thompson-Fawcett and Bond in 2003. To analyse whether Botany Town Centre could be considered best practice sustainable urban design, Thompson-Fawcett and Bond (2003) compared and contrasted the characteristics of the design against a detailed urban design matrix. The matrix, discussed in the next section, contained detailed criteria in four categories (physical form, social and community, economic, and process) to establish whether the development represented best practice in urban design.

3.11 Urban design matrix

Thompson-Fawcett and Bond (2003) developed an urban design matrix as a tool to enable comparative analysis of urbanist developments, and used the influential urban design movements of the Congress for the New Urbanism (CNU), and the Urban Villages Forum (UVF) as examples to represent best practice in sustainable urban design. This study has adapted the urban design matrix from Thompson-Fawcett and Bond (2003) to identify a set of criteria to establish what can be considered best practice sustainable urban design to reduce CO₂ emissions from land transport.

This matrix was selected to be used in this research due to the relevance of the NZ setting and the criteria used in analysis. As this matrix is now ten years old, it requires updating and has been adapted from its original form to allow for the specific focus of this research to be highlighted. Their study was more general in scope and so the original matrix contains a range of measures across physical, social, and economic criteria. Those criteria that are not relevant to reducing CO₂ emissions from land transport or relevant to a city centre redevelopment have been removed. In addition, any new criteria that have emerged in more recent literature have been included. The adapted urban design matrix continues to use the CNU and UVF as these movements are still considered best practice in sustainable urban design.

3.12 Summary

To explore sustainable urban design, literature from a variety of disciplines including spatial planning, environmental management, transportation policy, and urban design was analysed. This analysis established that four sustainable urban design variables; increased density, mixed-use development, street layout and city design, and the provision of sustainable public transport are the most successful in order to reduce CO₂ emissions from land transport. While movements, such as CNU and UVF, have successfully promoted these variables into planning practice internationally, few successful examples have emerged in NZ. This literature analysis establishes that a research gap into sustainable urban design has emerged in NZ and strong leadership from Central Government is required to provide national direction in this area.

Chapter 4 Context for the redevelopment

Christchurch is NZ's third largest city, with a population of 340,000 (Ansell & Thompson-Fawcett, 2008), and is located on the east coast of the South Island. On Saturday, 4 September 2010 a 7.1 magnitude earthquake struck the Canterbury region at 4.51 a.m. It was centred 40 kilometres (km) west of Christchurch, near Darfield, and struck at a shallow depth of 10km (GNS, 2012a). The earthquake lasted approximately 40 seconds, and was powerful enough to be felt widely across the South Island and north to New Plymouth, over 500km away. This earthquake, termed the Darfield earthquake, caused serious damage across the Canterbury region, severely affecting Christchurch. No fatalities resulted, largely due to the timing of the event which meant that the majority of people were off the street; however, buildings and homes were destroyed, and major disruptions to essential services such as power and sewerage occurred.

A second earthquake, known as the Christchurch earthquake, measured magnitude 6.3 and struck at 12:51 p.m. on Tuesday, 22 February 2011. The earthquake was centred two kilometres west of Lyttelton, and 10km south-east of central Christchurch (GNS, 2012b). Once again, severe damage occurred compounding the damage already suffered in the Darfield earthquake, including power outages, and destruction of homes, businesses, and vital infrastructure. At the time this earthquake struck, the central city of Christchurch was crowded, so as buildings, façades, and awnings crumbled and collapsed, tragedy ensued. On this day 182 people lost their lives and thousands more were injured. Significant liquefaction affected the city, producing around 400,000 tonnes of silt, and resulted in 600 ha of residential land becoming unsuitable for future development (Body & Davison, 2012). The Christchurch earthquake was reported to be felt across the South Island and the lower and central North Island. The Government declared a state of national emergency, which remained in force until 30 April 2011. Additional large aftershocks occurred on 13 June 2011 (causing considerable additional damage) and on 23 December 2011.

As a result of this series of seismic events, the central city of Christchurch has suffered enormous damage. Important physical infrastructure has been, and

continues to be, severely affected. Approximately 1200 buildings, 900 of which are located in the central city (defined as the area within the four avenues; Bealey, Deans, Fitzgerald, and Moorhouse, shown in figure 4.1, below. Note: Deans Avenue borders Hagley Park to the west, outside of the map area shown) are expected to be partially or fully demolished (Body & Davison, 2012). Major zones of ground shaking and liquefaction have damaged roads, bridges, footpaths, water, gas and sewerage pipes, and electricity and telecommunications lines. Businesses have been forced to close and Christchurch has suffered significant damage to important social and economic systems that make up a city's appeal such as retail, entertainment, educational, and cultural facilities. Approximately 71ha of the central city has been categorised as the 'red zone', meaning buildings within this area, including over 113 heritage buildings must be demolished (Body & Davison, 2012).

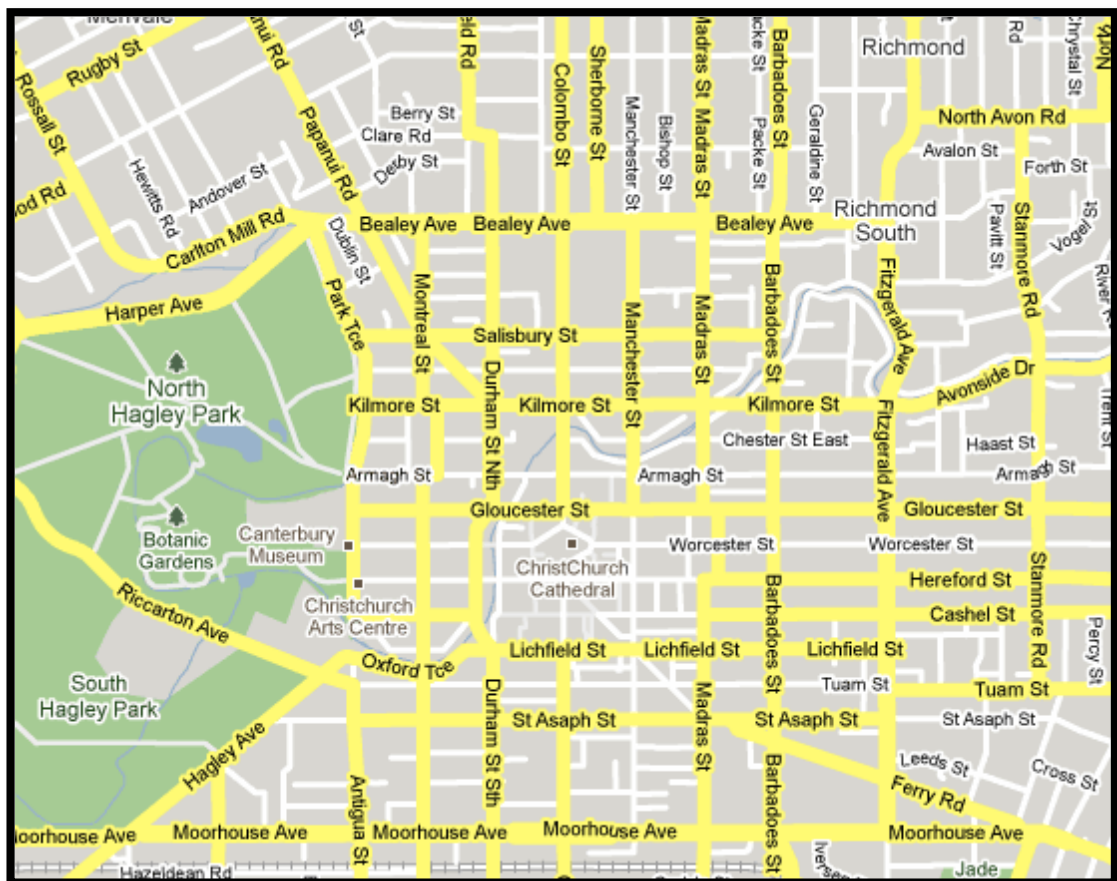


Figure 4.1: Central city of Christchurch. Source: Google Maps (2013).

The damage caused by these earthquakes represents an opportunity to redevelop the central city of Christchurch to mitigate the effects of climate change by reducing

CO₂ emissions from land transport. Due to the liberalisation of planning policy in the 1980s, recent urban development patterns had diminished the quality and relevance of the central city, and expansion of low density suburbs led to high private car use amongst residents (Gjerde, 2012). Officials responsible for planning within Christchurch and the Canterbury region have demonstrated an awareness of urban design issues and recognised the need for revitalisation of the central city prior to the earthquakes. This understanding resulted in the ratifying of the NZ Urban Design Protocol and the development of the Greater Christchurch Urban Development Strategy (UDS) in 2007, which was developed in recognition of increasing pressures associated with growth throughout the Canterbury Region.

4.1 Pre-earthquake planning and policy documents

The UDS is a collaborative effort between Christchurch City Council, Waimakariri District Council, Selwyn District Council, Environment Canterbury, Te Runanga o Ngai Tahu, and the NZ Transport Agency to address growth issues, provide suitable infrastructure, demonstrate leadership, and establish urban growth boundaries to consolidate land use and create a more compact city form. The UDS identifies several growth issues including:

- dispersed urban growth resulting in increased distances of key journeys;
- scarcity of quality open space;
- increased traffic volume and associated issues due to continued dominance of private automobile use;
- poor winter air quality; and
- increased risks associated with the effects of climate change (UDS Forum, 2007).

The UDS identifies several strategies for addressing these growth issues including good urban design, increased net residential density (50 households per ha in central Christchurch) and encouraging alternative modes of transport (UDS Forum, 2007). The most controversial aspect of the UDS was the introduction of urban growth boundaries for greater Christchurch to contain growth. The UDS defines the areas where growth will occur in the future and directs 71 per cent of expected growth within Christchurch City limits. However, these controversial planning

controls have been subject to on-going litigation by affected landowners and are currently non-operational.

The UDS was updated in 2010, and discusses and considers implications of climate change for the future of the city. One development approach stated in the UDS is 'to support international efforts aimed at limiting the severity of climate change impacts and move away from a reliance on carbon emitting fossil fuels' (UDS Forum, 2010, p. 250), while further issues identified include 'growth in greenhouse emissions from fossil fuels associated with transport and burning coal from urban development continues to rise' (UDS Forum, 2010, p. 250). The UDS also outlines some of the likely impacts of climate change on Christchurch including 'changes in the severity and frequency of extreme weather events is likely to impact on our community, economy and natural heritage', and 'projected sea-level rise of at least 0.5m within the next 80 years reduce the opportunity for new development in coastal areas and the redevelopment of some existing urban areas and will require managed retreat from low lying areas' (UDS Forum, 2010, p. 250). In conjunction with the UDS, a factsheet was created titled *Exploring new housing choices for changing lifestyles* that aimed to inform property developers, architects, and the general public, of the potential of high quality, higher density housing through demonstrating practical examples of how the density targets outlined in the UDS may be achieved attractively and in terms of liveability.

Christchurch also has a climate change strategy that was developed in 2010 prior to the earthquakes. This strategy outlined goals and targets for Christchurch to achieve in relation to climate change including prioritising low-carbon transport and a 50 per cent reduction of greenhouse gas emissions from domestic transport by 2040 (from a 2008 baseline) (CCC, 2010). These are key documents that outline strategies for urban development and climate change resilience prior to the earthquakes. It is also important to reflect on the key legislation and planning documents that govern the redevelopment of Christchurch.

4.2 The Resource Management Act

The major piece of legislation that governs planning and urban design in NZ is the Resource Management Act 1991 (RMA). Innovative at this time, this influential Act combined statutes from resource management, environmental and planning legislation, and devolved policy making, planning and implementation to local and regional level (Ericksen et al., 2003) 'to promote the sustainable management of natural and physical resources' (NZ Government, 1991, p. 65).

Created from the comprehensive resource management reforms in the late 1980s, the RMA was intended to provide a holistic and integrated approach to planning and reflected concerns over the inadequacies and inconsistencies of the fragmented method of environmental planning at that time (Memon, 1993). Prior to the RMA, resource management legislation was spread over several different Acts, such as the Town and Country Planning Act and the Water and Soil Conservation Act. The fourth Labour Government, who began the comprehensive restructuring, recognised an opportunity to 'streamline and rationalise the tangled web of statutes' (Memon, 1993, p. 91) that controlled environmental planning at that time.

The RMA creates a structured planning hierarchy which allows resource management decisions to be made at the appropriate level. Central Government retains an overview role as well as the direct management of mineral, energy and coastal resources, while regional and local authorities are delegated the responsibility for identifying issues, managing air and water pollution, controlling land use, and creating district plans (Memon, 1993).

The RMA has attracted criticism for not accounting for environmental issues arising from urban areas (PCE, 1998; Perkins et al., 1993; Perkins & Thorns, 1999). Under the RMA, local and regional authorities have increased responsibility for urban planning (Perkins & Thorns, 1999), leading to concerns that urban sustainability issues are being overlooked by Central Government (Hughes, 1999). Commentators have voiced concerns over the lack of governance, vision, and research funding on urban sustainability issues, and appealed for a systematic and supported research

plan relating to urban form, as well as increased information and assistance to Local Government on urban sustainability (Chapman, 2010; Hughes, 1999; PCE, 1998). An increased focus on urban sustainability occurred in the mid-2000s (refer section 4.1); however, due to the change in Government in 2009, priorities have changed and urban areas have once again been overlooked.

4.3 The Canterbury Earthquake Recovery Act

After the Darfield earthquake the Government rushed legislation through Parliament to assist with the redevelopment of Christchurch. It was controversial as planning controls, as well as other fundamental legislation, were able to be overridden by the Canterbury Earthquake Response and Recovery Act 2010. This legislation was repealed and replaced in April 2011 by the Canterbury Earthquake Recovery Act (2011) (the Act).

The stated purposes of the Act include:

- to enable a focused, timely, and expedited recovery;
- to provide for the Minister and the Canterbury Earthquake Recovery Authority (CERA) to ensure that recovery;
- to facilitate, co-ordinate, and direct the planning, rebuilding, and recovery of affected communities, including the repair and rebuilding of land, infrastructure, and other property; and
- to provide adequate statutory power for the other purposes (NZ Government, 2011).

Critics of the Act suggested that the legislation was draconian and were concerned that it afforded great, unilateral powers (Campbell, 2012) to the Minister of Canterbury Earthquake Recovery, Gerry Brownlee, who is able to suspend, amend, or revoke entire important planning documents, including city plans made under the RMA or conservation management orders (NZ Government, 2011). These concerns were heightened as previous infringements of the democratic process had been displayed by the current Government prior to the earthquakes. In 2010, 14 Environment Canterbury (ECan, the regional authority) councillors were dismissed from their elected roles due to perceived incompetence in resolving water

management issues in the Canterbury region (Smellie, 2010). This unprecedented move sparked criticism from the public and media as the Government had superseded democratic systems.

4.4 The redevelopment plans

After the earthquakes the Christchurch City Council (CCC) was directed by Minister Brownlee to provide draft central city redevelopment plans that were informed and inspired by a comprehensive public consultation campaign 'aimed at maximising community involvement in the redevelopment of the central city' (CCC, 2011, p. 21). The draft central city redevelopment plans were created after an unprecedented amount of consultation with residents and stakeholders. The public consultation campaign consisted of the creation of a website (shareanidea.org.nz), where residents, and other concerned stakeholders, could submit their views on the redevelopment. The website operated for six weeks, and generated 106,000 ideas from 58,000 site visits (CCC, 2011). A two day Share-an-Idea community Expo was held in May 2011 and was attended by over 10,000 people. More than 100 stakeholder meetings were also conducted with business and land owners, along with a series of ten public workshops (CCC, 2011).

The CCC provided the draft central city redevelopment plans to the Minister in December 2011; however it was not until April 2012 that Minister Brownlee appeared in a news conference to discuss them. The Minister did not give Ministerial approval to the draft central city redevelopment plans, and decided to put the transport aspects 'to one side for the time being' (Brownlee, 2012). The Minister also decided that other transport proposals in the plans, in particular the conversion of one-way streets to two-way and the light rail transit (LRT) proposal would be removed to allow further assessment as to the implications on the wider transport network (Brownlee, 2012). During this news conference the Minister announced his decision to delegate the role of the central city recovery to a new subsidiary unit within CERA, titled the Central City Development Unit (CCDU) (Brownlee, 2012). This places a huge amount of responsibility for the rebuild of Christchurch in the hands of Central Government, as the CCDU will make decisions that will affect the rebuild of the central city and affect the shape and feel of

Christchurch city for decades due to the long term nature of the built environment. The CCDU released further central city redevelopment plans on 30 July 2012, termed the Blueprint plans.

4.5 Summary

Two large earthquakes struck Canterbury in 2010 and 2011, causing severe damage to the central city of Christchurch, which requires extensive redevelopment. To underpin discussion regarding the redevelopment, the planning and political landscape needs to be understood. Prior to the earthquakes the Local Government were embarking on controversial planning controls to revitalise the Christchurch city centre and manage growth in the region. Through pre-earthquake planning and policy documents it is established that the Local Government had an awareness of climate change and urban design issues.

The magnitude of the disasters resulted in legislation to govern the redevelopment being developed in great haste, and with the power to supersede NZ's established planning legislation, the RMA. Central Government has drawn criticism for an authoritarian approach to the redevelopment, which can be contrasted to the Local Government's inclusive public consultation campaign and collaborative approach. The next chapter will build on this context by analysing interview participants' perspectives on sustainable urban design.

Chapter 5 Perspectives on sustainable urban design from interview participants

As shown in Chapter three, many authors have studied and described the relationship between urban design and CO₂ emissions. Through this literature several key variables within urban design have been promoted as having a significant effect on CO₂ emissions, namely density, mixed-use development, street layout and city design, and the provision of sustainable public transport. This chapter will answer research sub-question one (what are sustainable urban design variables to reduce CO₂ emissions from land transport?) by analysing how the urban design variables can achieve a reduction in CO₂ emissions from land transport using data from interview participants as evidence to support the discussion.

In order to explore interview participants' understanding about how sustainable urban design variables will reduce CO₂ emissions from land transport, they were asked what they considered the best sustainable urban design variables to be. One Local Government Official commented that "there is no real substitute for good urban form...you create a more compact and accessible city...the simplest way of reducing both your petrol and costs and CO₂ emissions" (Interview 4). This point was reinforced by a Central Government Official who regarded "making sure the city form and function is working well" as important (Interview 7), while another Local Government Official felt that:

The key outcomes that we want to achieve with urban design and urban renewal is creating people spaces...a pedestrian-dominated environment, so it's about creating those environments for people to access, to get out of their cars and then walk around basically, or have more active modes of transport such as cycling...it's about bringing life and vitality back to places (Interview 6).

An Academic stated that transport was important and that the provision of sustainable public transport was a key feature of urban design (Interview 11). This point was reiterated by another Academic who noted:

I think transport is an absolutely key part...we know there's such a strong link between land use and transport. If you get your transport wrong, it's very difficult to design a sustainable city. And the key things we need to be trying to do is develop a city where people don't feel the only choice they have is to drive (Interview 12).

There was a general understanding amongst interview participants that the four urban design variables discussed in chapter three were important in reducing CO₂ emissions from land transport. The next section will discuss interview participants' perspectives on the increased density variable.

5.1 Increased density

As noted in chapter three, increased density is perhaps the most important urban design variable that can influence CO₂ emissions from land transport, a point agreed to by nine out of 13 interview participants. The key quotes relating to increased density are captured in table 5.1, below.

Table 5.1: Interview participant's quotes relating to increased density

Theme	Quote
Problems of sprawl	How far does Christchurch sprawl across the Canterbury Plains? Because any block of land is pretty much the same as any other...but the local authorities in the late 90s and early 2000s all reached a point where it was becoming financially unsustainable for them to be building more and more infrastructure for a low density dispersed pattern...they're basically building a town like Auckland, that the only way you can get around it is that you have to have a car. So there's all this talk about freedom and freedom of choice, but you've actually got a land use pattern that locks you into a lack of choice. You don't have any choice. Whether you're rich or poor, you have to have a car because...everything is so dispersed from everything else (Interview 1, Local Government Official).
Avoiding the need to travel	If you have people living in more dense environments and you have good public services for transport, then you get better patronage. And the other part is that we are looking to put more people living around the city centre and also in those villages around the city, enable people to get to the things that they need without travelling very far. (Interview 5, Local Government Official).
	Residential intensification is about people living more closely [densely], and that has a number of flow-on benefits. One is making use of all infrastructure more

	<p>efficiently, so there's less of a need to build new infrastructure out at the edges of cities; particularly making use of transport infrastructure more efficiently, and reducing the need, the potential for people to have to travel long distances (Interview 11, Academic).</p> <p>If you're closer to stuff and you're closer to people then you have less distances to travel. If you have higher density you're more likely to have jobs and schools and stuff, so you're closer to stuff. One of the problems of Christchurch is you can live quite a long way from stuff and not live in concentrated communities...the more people you get in a smaller area the less distances they have to travel and therefore they're more likely to walk and cycle and use public transport (Interview 12, Academic).</p>
Linking public transport and density	<p>One of the issues I guess is about density...if you can create areas where there's greater population, then actually it makes public transport more viable (Interview 4, Local Government Official).</p> <p>I think actually having a higher density is probably the way to go, therefore you'd actually use less [petrol] and obviously with that comes more mixed-use and more use of public transport or different modes of transport like walking or cycling (Interview 9, Central Government Official).</p> <p>They've really got to get people living more densely, control the way private vehicles are used in relation to public transport to make that public transport more attractive and to get more people running on it (Interview 11, Academic).</p>
Density and vibrancy	<p>The view is that a strong inner city residential population...means you've got more vibrancy in the evening when the businesses close. You've got patronage for the galleries, the cafes, the restaurants, the bars from a local population, and also shops as well. So instead of relying on the office market and people who use those facilities in town as a destination, you've actually got a residential population (Interview 6, Local Government Official).</p>
Increased density is good design	<p>Good urban design, just like a bus system, needs high density (Interview 1, Local Government Official).</p> <p>We're talking about higher density, we're not talking about the lack of housing choice. We're not asking people to live any differently to the way they live today. If you want to live in a ten-acre block you can go and buy one, but where you can't live at the moment in Christchurch is in an apartment building. There aren't any (Interview 1, Local Government Official).</p>

Table 5.1, above, establishes that a range of interview participants agree that increased density is significant to urban development, a point stressed by an

Academic who states that the “key issue is about living more densely” (Interview 11). Specifically in relation to Christchurch a Local Government Official stated that Christchurch central city did not have “a large population by other city standards. And it was something that the Council wanted to increase quite significantly” (Interview 6). Increasing residential densities in the central city has “been a constant problem for Christchurch, to make it more people-centric, focus[ed] on walking”, according to a Central Government Official, who supports the ambition to increase the central city residential population (Interview 8b). However, increasing density may be difficult in the central city, as noted by a Local Government Official who recognises that in Christchurch, “there is no obvious topographical boundary which limits growth. So it is in fact easier just to keep spreading outwards as it is to hold it” (Interview 4).

A Local Government Official highlights the key aspect of density, as mentioned in section 3.6 and discussed by Ewing et al. (2008):

A more dense city...where you have amenity and services in close walking distance to where people live...enables you to have very efficient or more efficient transport, less demand in fact for transport and more walking and cycling and so on, that you can walk to your supermarket, you can walk to your schools, you walk to the doctor, and maybe you need transport systems to enable people to get to and from work, public transport ideally for that (Interview 5).

Table 5.1, above, shows that interview participants understand that increased population densities in the central city allow people to live near to key destinations, such as workplaces and shops, reducing the need to travel long distances, if at all, by private car, and that trips that are short in distance are more likely to be undertaken by alternative modes of travel, such as walking or cycling. This reiterates points made by ECOTEC (1993), Ewing et al. (2008), and Newman and Kenworthy (1999). Furthermore, interview participants understand that increased population density also supports public transport, producing increased ridership rates and improving viability, which is discussed further in section 3.6 and

reinforced by authors such as Newman (2006), Grazi et al. (2008), and Abrahamse and Witten (2011). The CCC identified the opportunity to make public transport more viable through increasing density prior to the earthquakes. The CCC (n.d., p. 10) state that 'the greater the number of people living in an area (i.e., higher density), the better quality and frequency of public transport services can be provided'. This point is reinforced by a Local Government Official who states:

More people will use it so...instead of having...20 houses...between any given two stop signs, you might have 40, so you've got twice the number of people who could potentially use it. And if you had five per cent of the population along a street using buses, you've now got twice as many people because you've got twice the population. But also with higher density, you get increased congestion in those locations as well. You get increased pressure for car park space. That's in buildings along the street but also in private residential developments, so you tend to become more and more active or PT focussed type of developments in higher density environments as well. So again, it supports the use of public transport and sustainable transport (Interview 6).

The UDS (refer section 4.1), developed for Christchurch prior to the earthquakes, targets a central city density of 50 dwellings per ha; however, an Urban Design Professional points out that this figure is "still pretty low by international standards" (Interview 10). Unfortunately the Blueprint plans, despite encouraging increased densities through seeking a more compact central city, does not declare a target. In 2008, Christchurch's central city density was 12 people per ha, while density in the central city of Wellington is 42 people per ha, and Copenhagen's central city density is 66 people per ha (Gehl Architects, 2009). This indicates that significant work is needed on this variable in Christchurch and more ambition to increase density is required. In order to influence density a Local Government Official suggests that:

Regulation is one tool...land use regulation...you can buy investments, so you can invest in amenity and transport infrastructure and community facilities, you can encourage people to cluster around that by advocacy...so

those are probably the three main tools: investment, advocacy and regulation...they don't control the thing [density]; they can influence it (Interview 4).

Despite the current lack of density, most interview participants agree that it is important and suggest that other economic, social and health benefits also arise from increased density and reducing car dependence. Local Government Officials noted that "the obesity epidemic, the health thing; that's huge" (Interview 1), and suggesting that dense, mixed-use areas are a "much more healthy city model" (Interview 4). Increased social capital is also referred to as a positive co-benefit, with an Academic highlighting that "if people walk and cycle and use public transport they actually talk to people, and we know there's links between social capital and health" (Interview 12). These points are reinforced by literature including ECOTEC (1993), who argue that increased density leads to 'increased opportunity for local personal contacts', resulting in increased social capital, and Giles-Corti (2011), who highlights the association between declining levels of physical activity, poor health, and social problems, due to poorly designed urban environments. Sustainable urban design highlights linkages between environmental, health, and economic costs, as discussed by an Academic who comments:

Obesity we're not solving, we're not doing anything about and it's eating up an increasing amount of the health budget. So as soon as you factor obesity in, cycling becomes incredibly cost effective to invest in (Interview 12).

The economic benefits to businesses can also justify increased density as stressed by another Academic, noting that:

You don't find many shops out in suburban areas because the catchment's pretty low. You find a lot of shops in places where people are living more densely and new shops will open up...because there is enough of a critical mass for businesses to think that they can capture some of that (Interview 11).

An excellent sustainable urban design variable relevant to retail areas and residential areas is through mixed-use development. Interview participants' perspectives regarding this sustainable urban design variable are discussed in the following section.

5.2 Mixed-use development

As with increased density, many interview participants identified mixed-use development as a key variable of sustainable urban design and one that would be important in the redevelopment, but perhaps difficult to implement in Christchurch. Mixed-use development can be mixed horizontally (i.e., a residential complex situated next to a commercially occupied building), or it can be mixed vertically (i.e., retail, commercial, and residential space in the same building). A vertical mix can be described as "a residential complex...with cafe, food and beverage on the ground floor...you could put offices in and then have the upper storeys as apartments" (Interview 6). Similarly, an Academic describes mixed-use development as "shops on the ground floor and then small businesses on the second floor, and then people living above, like [what] happens in Europe quite a lot" (Interview 12).

Mixed-use development can reduce the need for private car travel due to close residential population proximity to key destinations, reducing the distance between key points, and enabling a wider variety of transport choices. This point is highlighted by a Local Government Official who states:

If you can separate everything out, then yeah absolutely you have to use a car, there are no alternatives...whereas if you can have some of the shops mixed up with the residential areas...then it enables you to make a certain percentage of the trips walkable rather than drivable (Interview 4).

Despite the benefits of mixed-use development, property developers have been reluctant to implement a vertical mix in their central city buildings in Christchurch. A Local Government Official comments that developers:

Tend to shy away from fully mixed with the offices and residential side. I'm not entirely sure why, whether it's the economics or how the two activities interact...or the developer tends to build residential and this developer

builds offices and they don't seem to crossover...but there appears to be a reluctance to do that (Interview 6).

An Urban Design Professional reiterates this point by explaining that developers:

Tend to like quite simple ways of managing their properties. They just have a commercial management arrangement, and they don't necessarily want to get into the rental market above or they don't want to sell off part of their building and get into complicated ownership structures (Interview 10).

This point is confirmed by Cervero and Duncan (2006) who report that opposition to mixed-use development is common due to the perception that diverse uses may reduce property values. In order to overcome this opposition a Local Government Official believes that:

We really need to see some positive examples...you look internationally and there's some very good mixed-use developments and we probably need to see a few more of those in NZ before it gets widespread acceptance (Interview 4).

However, an Urban Design Professional also highlights the difficulties of accommodating different types of tenants, particularly in an active seismic area:

You have a government agency who wants a high strength structure, to the highest, most costliest strength, and then you have other tenancies who might not want to spend that sort of money, 'cause obviously the more strength you have, the higher the build cost, the more your floor rates increase (Interview 10).

An Academic believes that mixed-use development "is seen as the better way to go now" (Interview 12) rather than zone based planning; however it is relatively uncommon in NZ (Chapman & Howden-Chapman, 2010). This may be due to NZ's RMA based planning system, which is permissive to development (Chapman, 2008) and a political reluctance to erode this freedom by creating rules forcing this type of

development. This issue is highlighted by a Local Government Official who comments:

Property interests, the so-called right of people to do whatever they feel like with their property...and the onus on anyone objecting to that is to produce the evidence, the hard evidence, as to why this property development should not go ahead. That's the presumption within the RMA (Interview 1).

So although interview participants agree that mixed-use development should be encouraged within the redevelopment of the central city of Christchurch and this variable can assist in reducing CO₂ emissions from land transport, there are difficulties in implementation. These difficulties can also occur in the street layout and city design variable, which will be discussed in the following section.

5.3 Street layout and city design

Chapter three noted the importance of the street layout and city design variable by showing a broad consensus in the literature that suggests that encouraging active modes of transport, such as walking and cycling, is an important urban design variable to reduce CO₂ emissions from land transport. An Urban Design Professional suggests sustainable urban design can encourage active modes of transport by creating places that are "Attractive and enjoyable, more interesting, stimulating...it does start to break down those perceived times and people are prepared to walk a bit longer" (Interview 10). Another Local Government Official concurs with this priority by commenting "we'd rather make a more pleasant environment, once you're in the central city, for the people and users" (Interview 6), which is reinforced by another Local Government Official who states "transport choice was one of the core principles we were looking at, and really we were trying to make it attractive for walking" (Interview 4). The street layout and city design variable can assist in encouraging active modes through increasing connectivity, calming traffic, and providing cycling infrastructure.

5.3.1 Increased connectivity

As noted in chapter three, increased connectivity encourages walking as an alternative to automobile transport, as more connected areas (e.g., grid pattern

street network) offer more direct routes to destinations than less connected, curvilinear pattern street network (e.g., cul-de-sac)(Lawrence Frank & Company, 2008). Pre-earthquake Christchurch was characterised by a historic grid pattern street network within the central city. Due to the large number of turning possibilities this grid pattern made the central city very interconnected (Interviews 4, 6, 10, 11), which is an important urban design feature to reduce CO₂ emissions from land transport (Calthorpe, 1993; Holtzclaw et al., 2002). An Urban Design Professional explains how interconnected streets functions better than a curvilinear (i.e., cul-de-sac, dead-end street) pattern:

It allows you to take different routes. It allows you to get to A to B potentially, or get to a whole range of different destinations in using different paths. So unlike the cul-de-sac and lollipop and loop roads and main arterials and that sort of tree-like structure, where you basically have to come all the way to this end to get even back out to another destination, at least in a grid structure you have matrices if you like where you can take a whole range of different routes to different destinations (Interview 10).

Christchurch's historic grid pattern will remain as part of the new, redeveloped city, which will contribute to reducing CO₂ emissions from land transport in the redeveloped city. Gehl Architects (2009, p. 14) describe central Christchurch's historic grid as a 'rational, flexible and efficient urban structure, that is easy to move around'. As such, the decision to retain the grid structure is a positive move to reduce CO₂ emissions from land transport. Further improvements could be made to increase the connectivity by converting one-way streets to two-way.

There is an opportunity to convert all one-way streets to two-way streets as part of the redevelopment. This would improve connectivity and calm traffic to encourage walking and cycling. Prior to the earthquakes, Christchurch had eight one-way streets which restricted accessibility and funnelled traffic through the centre of the city and, as noted by a Central Government Official, "makes getting around the city difficult at times" (Interview 7). Gehl Architects (2009, p. 32) note that there is

heavy traffic on Christchurch's one-way streets and these 'act as barriers for pedestrians'. A Local Government Official comments that:

The reason behind the one-way to two-way change is basically driven by an understanding and philosophy of streets in the central city should be about bringing people to the central city and allowing people to move around the central city (Interview 6).

This thinking was supported by an Academic who states:

The idea of the one-way streets was they are streets to get people through the central city fast and the new argument is well, we don't want anyone going through the central city fast, we will direct people who want to go through the central city to go around it rather than through it, so we get rid of the one-way streets as a part of that process (Interview 12).

Furthermore, converting one-way streets to two-way has the potential for revitalisation of streets as suggested by a Local Government Official:

If we want to encourage more people to live in the city, we want to encourage more retail, and we've always struggled to get people to live on those one-way streets, then we need to...reduce the speed of traffic, reduce the noise and reduce the one-way streets (Interview 3).

A Central Government Official agrees with this by saying "a big part of changing to two-way was to enable activity and people to use places more" (Interview 7). Improving cycling infrastructure can also enable activity within the central city, and is discussed in the following section.

5.3.2 Improving cycling infrastructure

As noted in chapter three, encouraging cycling as a mode of transport reduces the number of trips by private car. Encouraging cycling through urban design by improving cycling infrastructure links with increasing density and mixed-use development as people are more likely to cycle if there are shorter distances between key destinations. Government spending on cycling infrastructure in NZ is poor as the majority of the national transport budget is spent on roads (Woodward

& Lindsay, 2010), with cycle lanes generally consisting of just a strip of different coloured paint in between moving traffic and parked cars. In order to encourage further participation in cycling and increase the mode's share of trips, providing safe infrastructure must be a priority. Several interview participants agree that providing more cycling infrastructure and creating safer spaces for cycling will encourage a greater percentage of trips to be undertaken by that mode of transport, as noted in Table 5.2, below.

Table 5.2: Key quotes regarding improving cycling infrastructure

Theme	Quote
Safety	Safety is a huge thing...at the moment it's only the diehards that bother to hop on their bike. Because you cycle down Blenheim Road with all those trucks thundering past, inches off your shoulder (Interview 1, Local Government Official).
	One of the key handbrakes on going to that next level of cycling participation is safety concerns and that's primarily mixing with traffic (Interview 2, Local Government Official).
	The key thing is that people feel it is unsafe to cycle. And the key thing to making people feel safe is to keep them away from traffic. What you find in cities all around the world is that as you make it safer, you get more people cycling, and you also get a broader range of people cycling (Interview 12, Academic).
Infrastructure	We know that we should have higher rates of cycling given the terrain (Interview 6, Local Government Official).
	It would be good to have something physical between the road carriageway and the cycle lane, and it would be good if that's not just a fence but some landscaping or something that looks good (Interview 3, Local Government Official).
	We just have painted white lines on the road, and no signage to encourage people to cycle on quiet roads...so there's lots of things we can do, but ultimately the gold standard in the Netherlands seems to be...you'll never cycle on a busy road with traffic, you'll only cycle on quiet roads with traffic; most of it's a physical separation, even at roundabouts and junctions (Interview 12, Academic).
	As soon as you provide that good cycle infrastructure, you can then open it up to 20, 30, 40 per cent of the population (Interview 10, Urban Design Professional).
Cost	A lot of it's just been paint on the roads; that doesn't cost much...and that's been a huge benefit. It means the car driver knows that is where the cyclists can be and you're not to drive in their lane, and vice versa cyclists need to be polite to the road users. So I think that's been a huge benefit having those defined. Now that's a

	cheap...measure to make safer, more efficient use of existing road space...when you compare it to what NZTA are doing with their hundreds of millions (Interview 1, Local Government Official).
	Central Government...shows very little interest...there's not an enormous amount of money spent on it...the amount of money they [Central Government] spend is going down because they're spending all their transport budget on roads of national significance (Interview 12, Academic).
Tensions	There was a requirement...for buildings to increase the required number of cycle parking spaces...and that they had to be covered and secured. And also in this plan anything over 50 cycle parks in a building, you needed to have showers and lockers as well, again to facilitate active transport (Interview 6, Local Government Official).
	I guess one of the key tensions we always have for lines on the road is the loss of parking for businesses. Often you lose parking and you get to gain a cycle lane and that's always the tension that we face (Interview 6, Local Government Official).

International best practice suggests that physically separating cycle lanes from moving traffic is a good method to achieve increased participation. A Local Government Official suggests that the creation of cycle lanes is implemented differently in different countries and depending on the circumstances; however the city of Copenhagen is considered the world leader in providing cycling facilities. This interview participant describes how cycle lanes are designed in Copenhagen:

A cycle lane, which is preferably at a different level than the footpath, so you drop down on a kerb, or you put in a raised kerb between the footpath and the cycle way. Then you have parked cars and then you have traffic. So it's separated in that sense by a line of parked cars from the moving traffic (Interview 4).

Similarly, an Academic describes cycling infrastructure in the Netherlands and Denmark as "the gold standard" as a cyclist will rarely have to cycle with significant levels of traffic. Using the example of Copenhagen again, this Academic noted that often cycle lanes offer more direct routes to destinations that are often not even on existing road infrastructure, and likened these to:

Super highways for bicycles...paths that go where roads don't go at all. They go along canals or they cross fields, or whatever, but they're completely

separate. So it's not just separation from traffic, its routes that go where traffic doesn't go, and they're faster and they're more direct (Interview 12).

NZ has a long way to go to achieve that level of infrastructure for cycling, but interview participants agree that the physical separation of cycle lanes from traffic lanes should be a key element of the redevelopment of Christchurch (Interview 1, 2, 3, 4, 10, 12). For example, a Local Government Official suggested there needs to be:

Completely separated cycle ways from the traffic...maybe within the same corridor, but completely separated. You may start to attract the next 10 per cent of cyclists...the opportunity with all these blocks demolished is to widen corridors and deliver those sorts of things (Interview 2).

Similarly, an Urban Design Professional suggests that separated cycle lanes:

Actually capture a whole wider market...the people that aren't prepared to go out and risk weaving through traffic. And you open it up to people who are looking for that comfortable cycle journey rather than feeling as if they're battling the whole time to get through the traffic. And so by starting giving a bit more space you actually open up the percentage of people that could potentially use these cycle lanes vastly (Interview 10).

This interview participant suggested that further work needs to be conducted to create a comprehensive network of cycling infrastructure to encourage increased use of this mode. According to a Local Government Official there is a precedent for separate cycle lanes in Christchurch: "the cycle lane down the railway line from Papanui to Riccarton; that's a great thing...if they can implement more of those or extend measures like that" (Interview 1). Nevertheless, this is the exception and most cycle lanes in the city are only demarcated with paint (Interview 1, 4), as this method occupies less space in the road corridor.

When developing cycle lanes that are physically separated from traffic, a tension is created as competition for space in the road corridor is increased. The road corridor is the space designated as road between building areas and can vary from city to city and street to street. Planners and urban designers need to accommodate

footpaths, parking, cyclists, and automobile traffic within this corridor, which can be an issue in accommodating alternative travel modes such as cycling. According to a Local Government Official, the public and the CCC “want to have more separations for cyclists and most roads are only 20 metres wide, so there is a limitation to that. Having a wider corridor gives us more space to have more separation and more lanes for different modes” (Interview 3). However, due to the amount of damage caused by the earthquakes there is an opportunity in Christchurch to widen the road corridors in some areas which may allow for physical separation of cycle lanes (Interview 2). Gehl Architects (2009, p. 14) suggest that in Christchurch ‘the street width has potential to accommodate more uses than driving, parking and walking for example providing cycle lanes as well as seating and diverse landscaping’.

Another tension caused by the creation of cycle lanes is the loss of parking spaces (Interview 6). Businesses have traditionally not supported cycle lanes because of the loss of parking spaces near, or adjacent, to their business. Business owners have perceived this as a loss of revenue as potential customers cannot park near to their business so they go somewhere else. An Urban Design Professional indicates this need not be the case, citing the case study of Portland where:

They’ve actually had a huge increase in bicycle usage and cycling and people biking to work, they’re actually starting to take away car parks and turn them into cycle car parks. Once you get a bit of momentum going and more people using this, then the attitude starts to change in the businesses ‘cause you can fit 10, 20 cycles in a car space as opposed to one car which might only contain one or two occupants. And so actually the businesses are seeing that as quite a good opportunity and actually petitioning the Council to try and change those [parking spaces] (Interview 10).

Increasing and improving cycling infrastructure will encourage cycling as an alternative to private car travel. Walking can also be promoted as an alternative travel mode, and can be encouraged through traffic calming.

5.3.3 Traffic calming

Interview participants agree that one method to encourage walking and cycling in the central city is to use traffic calming design, which involves a variety of techniques including narrowing street widths, creating road side barriers, and lowering speed limits. A Local Government Official explains how traffic calming:

Tries to create a more uniform promenade where the dominance is given to pedestrians and cyclists along the corridor, not the roads that cross it, and then also to provide in many areas a slowing down [of traffic]...which would facilitate and encourage transport, active transport, walking etc along the corridor (Interview 6).

Another Local Government Official describes how traffic calming design can be practically implemented:

In those locations where we would like to have more priority to pedestrians, the Council would provide street furniture in accordance with that approach [traffic calming], so probably more and better street plantings, little kerb build-outs and things like that to support...spaces for people to linger and formal spaces to sit down as well...to facilitate that lingering, that 'stop and take time' rather than just transporting through (Interview 6).

These techniques need to be used appropriately and in combination as this Local Government Official explains:

We would only look at that on slow streets where people can safely move, vehicles and pedestrians could safely interact with each other. We were looking at the heart of the city having 30k an hour speed limits and having that kind of environment on some streets, but you wouldn't have that kind of environment on a 50k an hour street (Interview 3).

This Local Government Official felt strongly about traffic calming techniques as an opportunity in post-earthquake Christchurch by saying "we are definitely wanting to increase the emphasis on foot traffic" (Interview 3). Another opportunity within the

redevelopment of Christchurch, concerned with the provision of sustainable public transport variable, is the Light Rail Transit proposal.

5.4 Provision of sustainable public transport: Light Rail Transit

The provision of sustainable public transport is identified and discussed in chapter three as an important urban design variable to reduce CO₂ emissions from land transport. Interview participants noted that the provision of transport services is a fundamental part of urban design, planning and urban development (Interview 4, 11) and that there is strong interaction between transport and urban form (Interview 2, 5, 6, 12). One Local Government Official comments that transport, in particular LRT:

Helps drive the urban form that we're looking for. That was one of the main reasons why, apart from the transport benefits clearly...but actually it's about driving urban form through having that transport service. So that's one example of where there is a very strong connection between transport and urban form (Interview 5).

Due to the interaction between transport and urban form, many interview participants were concerned that the Minister did not approve the transport aspects of the draft central city redevelopment plans (refer section 4.4). A Local Government Official comments that: "I struggle with doing a plan without transport in it...I guess in an integrated plan, transport is an essential component" (Interview 4). According to a Central Government Official this was appropriate as implications with the wider Christchurch and Canterbury transport system are unknown; however it was noted that "if you changed particularly the transport environment within the CBD it will have knock-on impacts into the transport environment beyond it" (Interview 8b).

A light rail transit (LRT) proposal emerged from public consultation and was included in the CCC's draft central city redevelopment plans. It has been a controversial topic and centre of debate on the redevelopment of Christchurch. Several interview participants, including Academics and Local Government Officials,

view the devastation of the central city as an opportunity to introduce LRT (Interview 1, 2, 11, 12). A Local Government Official explains that:

With the land availability issue, there is that opportunity using the Minister's powers to quite quickly protect future corridors and protect potential station location in the future...because the powers he's got are quite unique. In a normal course of events, sort of a Public Works Act approach, it would take years and years and years to get through the process to get a designation to get the land protected. Whereas under the CERA Act, he could do that very quickly. Certainly within a year. So that is a particular opportunity (Interview 2).

An Academic adds to this point suggesting "If Christchurch is ever going to have [light] rail, now is the time to build it into any plans. If it's not in there now it will never happen, I don't think" (Interview 12). Similarly, a Local Government Official agrees by saying:

I think if looking out, say 20, 30, 40, 50 years, where does Christchurch want to go as a metropolitan area?...as the largest urban area in Australasia that does not have a passenger rail system...ideally it wants, it needs a passenger rail system. And so in my view they should just start building it (Interview 1).

While another Local Government Official explains that "the [light] rail is ambitious, it's looking towards the future, whereas the roads is very much about meeting current demand" (Interview 3).

Several interview participants agree that one of the benefits of LRT is the effect on land use and central city revitalisation; as noted by an Academic "if you don't get your transport right then your urban development falls flat" (Interview 12). This is reflected in the literature (refer section 3.9) including Cervero (1984, p. 133) who states that 'since LRT represents a relatively permanent investment along a fixed guideway corridor, it...has the inherent potential to influence urban growth, affect land uses, promote redevelopment, and increase nearby property values'. Newman et al. (2009, p. 91) reinforce this point by stating that LRT has a 'density-inducing

effect around stations'. Interview participants highlight the fact that Christchurch was considering LRT prior to the earthquakes as a means of central city revitalisation resulting in:

Our mayor and senior management at Council [going] on a tour of a number of cities in North America that had introduced rail...one of the reasons for really looking at rail was to encourage regeneration and stimulation of economic growth (Interview 3).

Therefore the CCC realised the potential of LRT, a point which is highlighted by a Local Government Official who explains:

The possible benefits of light rail are that you can actually change land use along the corridors, you can actually...transform bits of the city through the use of the light rail corridors...one of the things about light rail is that it would actually attract people to live in an area...a significant enough piece of infrastructure that can actually attract growth (Interview 4).

This point is reinforced by another Local Government Official who suggests that:

You can put in the transport service and then people will come, the development will come...it [LRT] can help with city revitalisation and that you get the urban form built up around the rail network. So we were doing it for two reasons: one about the transport, and the other about the investment in the city and a form that enables us to rely more heavily on public transport (Interview 5).

The relationship between density and LRT is important as highlighted by a Central Government Official who suggests:

You would actually have to have a far higher density on the light rail lines...you'd also have to be looking at what you were doing to the district plan to allow higher density...it only really works if you allow that higher density because you would need so much more, such as higher patronage to actually get it to pay for itself...you would have to have things like...a

minimum height. So you can only build here if you're building three to five storeys rather than a one storey house...Yeah, you put the light rail in and then the density comes on afterwards normally (Interview 9).

A Local Government Official supports this point by stating "We want an enhanced passenger transport system, and argue you can only get that if you have some sort of consolidation and increase in density" (Interview 1). In addition an Academic states:

What makes public transport more viable is having people live within walking distance of a corridor, of an efficient corridor. And so, yeah, living more densely around nodes that can provide links efficiently to other parts of the city where people naturally want to travel is a key feature (Interview 11).

It is clear that the relationship between density and LRT is important; however interview participants are divided on which should be implemented first, as LRT needs density to be viable, but an LRT corridor creates density. An Academic highlights the need to adopt a package of urban design variables to support LRT as "it may be a panacea to say that, well we put a light rail system in, it will solve all our problems. It won't unless we have people living close by and it runs efficiently" (Interview 11). Findings from Pushkarev and Zupan (1977, cited in Cervero, 1984) reinforce this concern as minimum thresholds of 25 million to 50 million square feet (approximately 2.32 million to 4.64 million square metres) of non-residential floor space in the central city; and an average residential density of nine dwellings per acre along a transport corridor of 25 to 100 square miles (approximately 64 to 259 square km) are required to make LRT viable and efficient.

These cost and viability concerns were the main reasons interview participants had reservations about LRT. According to a Local Government Official "a lot of people wanted it, but not many people wanted to pay for it" (Interview 3). Another Local Government Official develops the issue of cost further by saying:

There's two aspects to the cost. There's the build cost, but there's also the on-going operational cost. It comes back to population and population density. We could put in a light rail corridor tomorrow, but we wouldn't have many people on it (Interview 2).

However, an Academic explains that cost does not have to be a factor in the LRT proposal as "if you look at examples around the world it's actually comparable [cost] to build[ing] state highways" (Interview 12). He develops the argument by suggesting that Christchurch would actually be a cheap place to build LRT:

Because what makes light rail expensive is when you have to start building roads, so you have to build tunnels and cuttings and stuff, where in Christchurch it would all be on the flat. You wouldn't have to buy any land 'cause the roads are so wide. So it would be as cheap as anywhere in the world to put it in, but yeah, we have these ideas that it's really expensive, and I think they're probably not totally correct (Interview 12).

Newman et al. (2009, p. 94) reinforce this argument suggesting that LRT 'cost about the same per mile as most freeways', while Cervero (1984) and Newman (2012) argue that costs can, at least in part, be recouped through an increase in rates collected due to increased property values surrounding LRT. This would alleviate some cost and viability concerns; however an Academic points out the Government is not willing to spend money on LRT "because they're spending all their transport budget on roads of national significance" (Interview 12). This is a valid point, as the Central Government's land transport funding (refer section 3.10) is extremely unbalanced in favour of roading over alternative modes. Each year for the next decade, over \$2 billion is to be spent on roading, while the CCC (2011) estimate that \$2 billion would cover the costs for the entire first stage of the LRT proposal.

This section demonstrates that interview participants consider that the provision of sustainable public transport, such as LRT, is important in reducing CO₂ emissions from land transport. This variable can also link with the other sustainable urban design variables, in particular increased density, to shape urban form. However, LRT is controversial in Christchurch due to current low density and cost.

5.5 Summary

Participants from a range of organisations were interviewed to provide their perspectives on what they considered the best sustainable urban design variables to reduce CO₂ emissions from land transport. This chapter presents the results of the analysis of their responses, which reflect results from the literature analysis (refer chapter three). This further establishes that the four sustainable urban design variables of increased density, mixed-use development, street layout and city design, and the provision of sustainable public transport are considered the best to reduce CO₂ emissions from land transport.

Through the interview data analysis, it became clear that Local Government Officials generally advocated the Local Government urban development agenda, which was emerging prior to the earthquakes through planning and policy documents (refer section 4.1). Central Government Officials, although generally supportive of the variables, adopted a more cautious approach to the variables' effects. Academics and Urban Design Professionals generally supported Local Government views. The views of different organisations involved in the redevelopment will affect the outcomes observed in the redevelopment plans. The next chapter will evaluate the redevelopment plans against an adapted urban design matrix to determine whether their implementation will likely achieve a reduction in CO₂ emissions from land transport.

Chapter 6 Evaluation of central city redevelopment plans for Christchurch

As shown in chapters three and five, the findings within the literature on sustainable urban design largely reflect the interview data collected for this research. This chapter will answer research sub-question two (how are sustainable urban design variables reflected in the redevelopment proposals for central Christchurch?). It will discuss whether the Central Government's Blueprint plans are likely to achieve a reduction in CO₂ emissions from land transport, and discusses the differences between the Blueprint plans and the CCC's draft central city redevelopment plans. The adapted urban design matrix from Thompson-Fawcett and Bond (2003) will be used to augment this discussion by evaluating how successful the plans are in the reduction of CO₂ emissions from land transport. This chapter will use the sustainable urban design variables discussed in chapter three (increased density, mixed-use development, street layout and city design, and the provision of sustainable public transport), to analyse the redevelopment plans for the central city of Christchurch. The first section will discuss how increased density is addressed in the redevelopment plans.

6.1 Increased density

The extent to which the Blueprint plans and associated projects will assist in achieving increased density in the redeveloped central city of Christchurch is considered here and evaluated against the adapted urban design matrix. Specifically the Blueprint plans state that the redeveloped central city will offer a variety of residential development to provide 'people the option of living close to where they work' (CERA, 2012a, p. 37). The Blueprint plans also highlight that 'a diverse residential population is essential to support business growth and development, and create a high level of activity' and that 'there will be opportunities for residential development throughout the central city' (CERA, 2012a, p. 81). The projects that relate to density within the Blueprint plans are The Frame, the height restriction, and the Residential Demonstration project.

In the Blueprint plans a more compact central city form is sought through the creation of the Frame- a border of greened open space that will define clear

boundaries for a more compact city centre. This will encourage increased density and provide for a compact and walkable city core. This approach is advocated by planners and urban designers to define areas into distinct walkable neighbourhoods, creating pedestrian-sheds of approximately five minutes' walk or 400 metres from centre to edge (Calthorpe, 1993; Duany et al., 2000). The Frame encompasses whole city blocks between Saint Asaph and Tuam streets in the South, and between Madras and Manchester streets to the East (see figure 6.1 below).

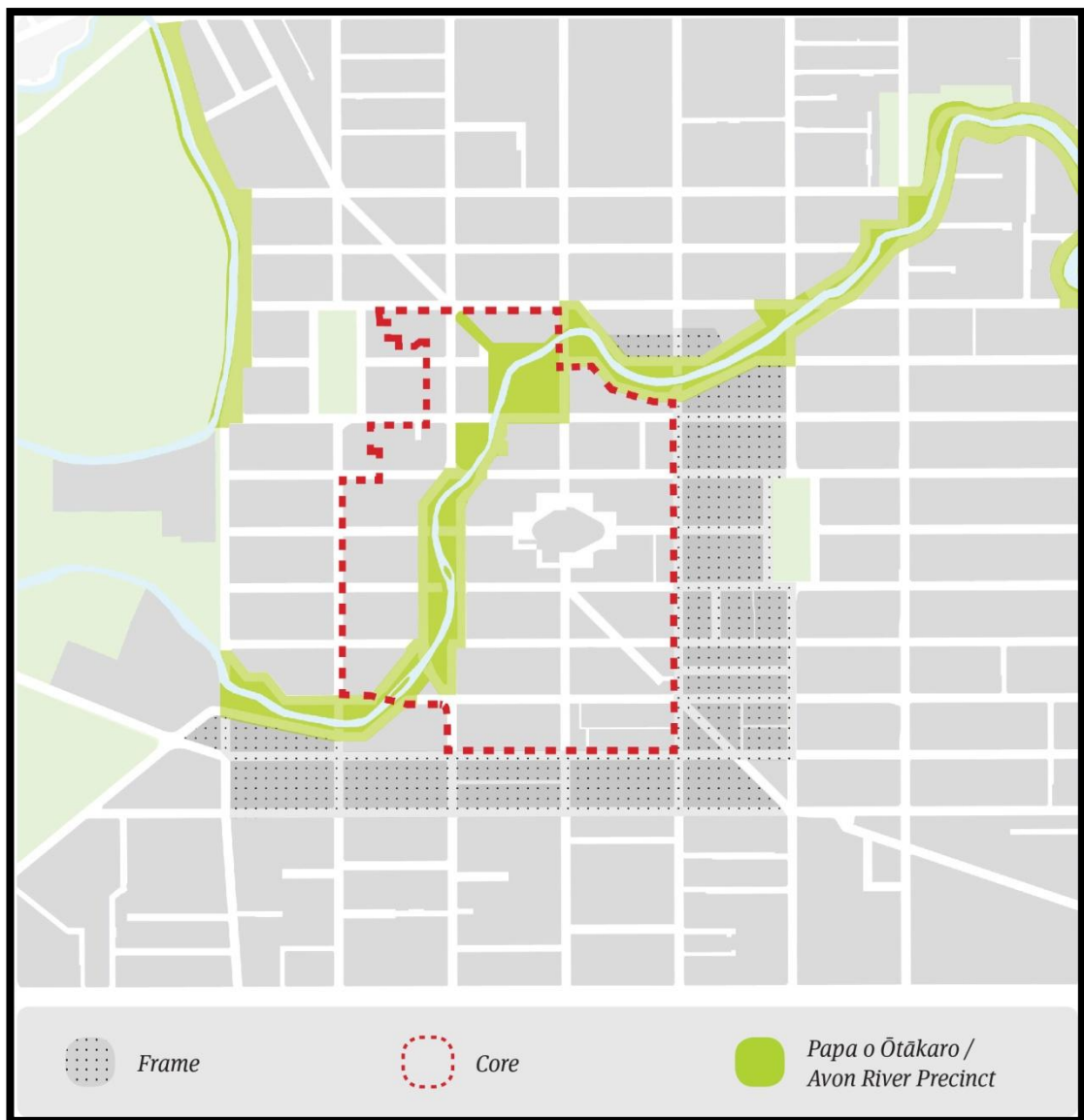


Figure 6.1: Map of the central city of Christchurch showing the Frame and the Avon River Park (CERA, 2012a, p. 37).

Further parts of the Frame are incorporated into the newly established Avon River Park (refer section 6.3.1, below) that forms another border for the central city to the North and West. The Frame links with the Avon River Park to increase amenity value and recreational space within the central city and provide a large and continuous walking and cycling area around the central city. It is likely that more residents will choose to live in the central city as they can access this high amenity and recreational space.

Within the central city as defined by the Frame, the maximum allowable building heights will be 28 metres (m). The justification for this is the 'economic realities and market demand' (CERA, 2012a, p. 40) for space in the central city, indicating an over-supply prior to the earthquakes. Prescribing a height restriction on a more compact central city will not assist in reducing CO₂ emissions from land transport however, as lower value residential space may be overlooked for development. Urban design guidelines, such as those advocated by the CNU, also suggest that density should increase from the edge to centre (Duany et al., 2000). This height restriction will result in uniform building height, as developers often build to the maximum allowed within planning rules to maximise profitability of their space. Public sector officials will need to work through these issues with the private sector investors.

This type of collaboration is advocated in the Residential Demonstration Project, which aims to highlight the potential of high-quality medium-density residential living in the central city. The outcome intended is an increase in the central city residential population to create vibrancy and custom for central city businesses (CERA, 2012a). An Urban Design Professional agrees that demonstrating high quality central city living is important:

We actually did some reviews of existing development, and there's actually not a lot out there, so people haven't got anything tangible to see. There's been quite a lot of research, but a lot of that hasn't filtered through to the development community yet and so the examples are few and far

between...so it is quite difficult to try and convince people [of the benefits of] central city living (Interview 10).

This point is re-iterated by a Local Government Official who believes that:

People in NZ haven't seen the good examples of mixed-use or medium density living. We've seen lots and lots of crappy examples and people go, 'oh I don't want to live in a shoebox' or 'I don't want to live in a building where I just stare at the wall of the building beside'...we need to give developers confidence in the residential market, the more dense mixed-use living arrangements...one of the ways we can give them confidence is...actually showing them the market potential, and what we're doing is doing some surveys of our residents...to help show developers that there is a market for this mixed-use medium density urban form (Interview 5).

Similarly, another Local Government Official concurs with this statement and questions "if there physically are no such things there, then how does the public know that this is a desirable lifestyle or option?" (Interview 1). A further benefit of the Residential Demonstration project and the resulting increase in density is a benefit to businesses, as described by an Urban Design Professional:

The response we've had from the business community is that they'd quite like an incumbent community to keep their workforce there, their customer base ticking over. It's just sort of this ready population that continuously using the CBD, and I think that's a real benefit of having more residents living near the centre (Interview 10).

6.1.1 Increased density evaluation and matrix

The Blueprint plans have been evaluated against the 11 criteria relating to increased density outlined in the adapted urban design matrix (see table 6.1, below), and will meet nine (81 per cent) of these, due to the Frame, the Residential Demonstration project, and the Avon River Park.

Two criteria will not be met due to the height restriction set out for the central city, which will result in fully commercial developments being favoured over mixed-use

or residential developments to maximise profitability. An opportunity has been missed in this regard as unrestricted building heights should be allowed in the plans to encourage residential and mixed-use developments. Central and/or Local Government have also missed an opportunity to drive this type of urban development by acting as a property developer. A partnership approach with private developers has been taken in the Residential Demonstration project, and the outcomes of this approach will be scrutinised.

The Blueprint plans do compare favourably with the draft central city redevelopment plans, due to the addition of the Frame which will encourage density and create a compact city centre. This evaluation finds the Blueprint plans for the redevelopment of the central city of Christchurch will produce increased density and thereby reduce CO₂ emissions from land transport. It needs to be noted that interview participants are less optimistic that increased density will result from the implementation of the Blueprint plans as NZ's permissive planning regime merely allows this type of development rather than enforcing it. Another missed opportunity results as the planning rules for the central city could be changed to enforce desirable development.

Table 6.1: Adapted urban design matrix showing density criteria

Density criteria	Urban Villages Forum	Congress for the New Urbanism	Blueprint plans for central city	Draft central city redevelopment plans	Justification
PHYSICAL FORM CRITERIA					
The Site					
Size allows sense of familiarity	●		✓	~	The Frame helps create a compact, dense city. The draft central city redevelopment plans did not take the opportunity to enhance the site by creating more compactness
Size allows prosperity and liveliness	●		✓	~	The Frame
There is a 5–10 min walking distance to all daily needs	●		✓	~	The Frame
Size supports a wide range of activities	●		✓	~	The Frame
Integration with Region					

Development is part of a comprehensive regional plan that seeks to limit automobile dependence and preserve open space		●	✓	✓	The plans link with the Greater Christchurch Urban Development Strategy (refer section 4.1)
Layout					
City centre has a centre and an edge	●	●	✓	✓	The Frame and the Avon River Park provide the central city with an edge. The Square provides the centre
City centre is compact, mixed-use and pedestrian friendly	●	●	✓	~	The Frame and Avon River Park
The highest density and urbanity surround the centre	●	●	X	X	The Frame helps create a compact city while the Residential Demonstration project should encourage higher residential density in the central city
Compact and varied	●	●	✓	X	The Frame
Density decreases from centre to edge		●	X	X	Height restriction will result in some lower value residential projects not being developed
ECONOMIC CRITERIA					
Sustainability					
Higher densities and vehicle independence offer savings over sprawl		●	✓	✓	The plans encourage increased densities through the Frame and the residential Demonstration project. The UDS discourages sprawl
Key: ✓ meets criteria X does not meet criteria ~ partially meets criteria ● criteria endorsed by urbanist group					

6.2 Mixed-use development: Mixed-use zone

This section will outline the projects that will assist in achieving mixed-use development in the redeveloped central city of Christchurch and have been evaluated against the adapted urban design matrix. The only project within the Blueprint plans to specifically involve mixed-use development is the mixed-use zone. The objective of the mixed-use zone is to develop 'vibrant urban areas where a diverse and compatible mix of activities can coexist' (CERA, 2012b, p. 15), and enables 'opportunities for office and commercial service activity in association with other business and residential activity' (CERA, 2012b, p. 15). The mixed-use zone supports residential intensification within the central city by prescribing development rules that enhance central city living, such as minimum residential unit size and the provision of outdoor space. Unfortunately, the majority of space allocated to the mixed-use zone lies outside the four avenues; nevertheless residential development is allowed inside this area. This represents a missed opportunity to encourage and enforce mixed-use development across the whole of the central city.

6.2.1 Mixed-use development evaluation and matrix

The Blueprint plans have been evaluated against nine criteria relating to mixed-use development contained in the adapted urban design matrix (see table 6.2, below). Through this evaluation it has been determined that the Blueprint plans will meet three of these criteria (33 per cent), due to the creation of the mixed-use zone in the central city. However, it is difficult to ascertain whether this encouragement will lead to increased mixed-use development in practice, as this depends on factors outside decision-makers' control, such as private investment and demand for residential inner city living. Mixed-use development is not incentivised or enforced through the redevelopment plans due to the freedom supplied by the planning laws in NZ. Incentivising this type of development is uncommon in NZ, a point highlighted by an Academic:

You go overseas and there are incentives that are embedded in plans. We are absolutely anti-bonuses...perhaps a development that incorporated a certain level of residential development and, particularly if that residential

development was of mixed tenure, that a developer could enjoy greater development potential. They may get an extra floor...they could actually incentivise certain types of development. We don't do that in this country and I think that's a flow-on from perhaps some bad experiences with incentivising in the mid-eighties (Interview 11).

This represents a missed opportunity within the redevelopment. Planning rules could now be changed as part of the redevelopment changes to incentivise or enforce mixed-use development. It is for this reason that the Blueprint plans will only partially meet the remaining six criteria. Therefore the Blueprint plans are unlikely to achieve a reduction in CO₂ emissions from land transport through the mixed-use development variable. There are no differences between the Blueprint plans and the draft central city redevelopment plans as the mixed-use zone was also intended to be implemented in both sets of plans.

Table 6.2: Adapted urban design matrix showing mixed-use development criteria

Mixed-use development criteria	Urban Villages Forum	Congress for the New Urbanism	Blueprint plans for the central city	Draft central city redevelopment plans	Justification
PHYSICAL FORM CRITERIA					
Integration with Region					
Mixed-uses encourage incremental, organic change in adjacent areas	●		~	~	Mixed-use zone encourages mixed-use development within the central city
Layout					
City centre is mixed-use	●	●	~	~	Mixed-use zone allows this type of development, but it is not located across all of city centre
Building types are 'zoned' by size not use		●	~	~	Height restrictions will achieve uniform height, so no size difference likely
The main street or central area provides for shops, bars, and restaurants on ground levels with offices and apartments above	●	●	✓	✓	Main Streets project allows for mixed-use development (refer section 6.3.2)
Architecture and Design					

Uses are mixed within buildings, especially in central area and on main streets	●	●	~	~	Mixed-use development is encouraged in the plans; however it is difficult to determine whether this will be implemented within private development
SOCIAL AND COMMUNITY CRITERIA					
Variety of activities encourages vitality, a sense of security and conviviality	●		✓	✓	The plans encourage mixed-use development and increased residential density
Mixed-uses					
Development encourages mixed-uses at compact densities	●		✓	✓	The plans encourage mixed-use development and increased densities
Uses are mixed within streets, blocks and buildings	●		~	~	Mixed-use zone and Main Streets project
Industrial and commercial tenures are mixed	●		~	~	Mixed-use zone
Key: ✓ meets criteria X does not meet criteria ~ partially meets criteria ● criteria endorsed by urbanist group					

6.3 Street layout and city design

In order to reduce CO₂ emissions through the street layout and city design variable the redevelopment plans will have to address increasing connectivity, traffic calming, and improving cycling infrastructure in the central city.

6.3.1 Connectivity

Prior to the earthquakes, the Christchurch city centre was connected through the historic grid street pattern, which it is to be retained as part of the redevelopment. To further provide increased connectivity and accessibility into and through the central city, the Blueprint plans include the Avon River Park project. This project will create a continuous walking journey along the banks of the river, and prioritise and accommodate pedestrian, cycling and recreational facilities to encourage people to use this as a route through the city rather than driving. This concept is shown in

figure 6.2, below. The CCC (2011, p. 47) describe the Avon River Park as ‘a softer, sinuous relief to the city grid and complement the diagonal routes of Victoria and High streets across the central city’.



Figure 6.2: Avon River Park concept image (CERA, 2012a, p. 54).

A method used to encourage walking and cycling along the Avon River Park is changing the street design by converting one-way streets to two-way. According a Local Government Official:

There are a couple of one-way streets that run alongside the river and so the feeling was that having a whole lot of traffic going at high speed next to the river would detract from the amenity of the river and the desire to make better use of the river and turn it into a park. So that was why a couple of one-way streets were proposed to be converted to two-way, to slow traffic down and to be able to narrow down the road so that there would be less space for the road and more space for the park and less traffic (Interview 3).

This comment is supported in literature by Duany et al. (2000, p. 160) who recommend all streets are two-way and note that speeds are increased on multiple lane one-way streets due to ‘less friction from opposing traffic and because of the temptation to jockey from lane to lane’. As discussed above, the historic grid street pattern will be retained; however, enhancement of the connectivity of the grid

pattern could have been attained by changing all previous one-way streets to two-way streets. It was the CCC's intention in the draft central city redevelopment plans to convert all eight of Christchurch's one-way streets to two-way; however this proposal has been scaled back by CERA in the Blueprint plans. Only two one-way streets (Salisbury and Kilmore) will be converted, and one street, Tuam, will be converted from two-way to one-way. This represents a departure from international best practice and is a missed opportunity within the redevelopment of the central city of Christchurch to reduce CO₂ emissions from land transport. However, Central Government Officials felt that the one-way to two-way proposal was "quite ambitious...and that's not something which you can easily work out the consequences of" (Interview 8a). A Central Government Official also felt that "it's something the council could do themselves...they don't have to do it as part of recovery" (Interview 7).

Another practical method to increase connectivity in urban areas is to create laneways through which pedestrians can quickly access points of interest. An Urban Design Professional explains the rationale of increasing connectivity through laneways:

What we're actually trying to do is break down the grid a little bit more in terms of providing laneways and through block links, so trying to increase the permeability particularly around some of those more intensive areas of use, and so create or diversify the grid a little bit (Interview 10).

A Local Government Official agrees:

Some of the blocks are too long, especially the east/west blocks are 200 metres long...but we were looking at creating laneways through some of the blocks to increase the connectivity (Interview 3).

However a Central Government Official (Interview 7) disagrees with this proposal as they felt that the laneways proposal was outside of the scope of the recovery and could be achieved by the Council through a regular plan change outside the redevelopment process. This is a difference between the plans, as the draft central

city redevelopment plans nominated the laneways as a significant initiative; while the Blueprint plans do not mention this as an explicit project. Pedestrianising laneways and increasing connectivity encourage walking and cycling, which can also be achieved through traffic calming.

6.3.2 Traffic calming

Traffic calming is proposed in the Blueprint plans to prioritise and encourage walking cycling along certain routes within the central city. The Main Streets project helps to achieve this in the central city by slowing traffic speeds to a maximum of 30 km/h, discouraging private car through traffic, and landscaping to a high standard through street trees and furniture, to provide an attractive landscape (see figure 6.3, below).



Figure 6.3: Main Street showing street plantings and street furniture to slow traffic (CERA, 2012c, p. 8).

A Local Government Official describes the Main Streets project as:

Key streets from the edge of the centre of the city into the heart of the city, which would have wider footpaths, more street trees, street furniture to encourage people to walk (Interview 3).

Both the draft central city redevelopment plans and the Blueprint plans reflect a priority of traffic calming to encourage pedestrian and cycling use; as such there are no significant differences between them. One further method used to prioritise cycling is to improve cycling infrastructure, which is discussed in the following section.

6.3.3 Improving cycling infrastructure

In order to accommodate and encourage alternative transport modes, such as cycling, the Blueprint plans labelled certain streets as priority areas for different modes of transport, for example, some streets are prioritised for buses and some streets are prioritised for cycling (Interview 10). As explained by an Academic, this prioritisation can be further enhanced by:

Actually [having] some sort of network...we don't have any signage to direct cyclists to go on quiet roads, so pretty much the cycle ways are on the main roads, and if you choose to go another way it's by trial and error; there's no way of identifying better routes (Interview 12).

This Academic notes that signage has been an important aspect of encouraging cycling in other parts of the world, such as North America (Interview 12). Unfortunately, the routes with the most traffic are generally the most direct routes between key destinations, which are also the routes that cyclists want to travel along (Interview 1).

A Local Government Official describes the requirement to provide cycle parking spaces as "one of the most restrictive standards" (Interview 6) in the draft central city redevelopment plans, because any building with over 50 cycle parking spaces also was required to provide showers and locker facilities in an effort to further encourage active modes of transport (Interview 6). This detail has been omitted from the Blueprint plans and reflects an overall disregard for improving cycling infrastructure. A Central Government Official sums this up by commenting:

I don't know whether it will be a major thing...I don't really think they [the Central Government] care in the short term. It might be something that's looked at in...five years...10 years maybe (Interview 7).

Unfortunately not much detail is provided on exactly how these projects will be implemented especially in relation to whether cycle lanes will be physically separated from automobile traffic and how much funding will be designated to these projects. The Blueprint plans state that separated cycle lanes will be created “where possible” and that the safety of cyclists on major cycle routes will be “prioritised at busy streets and intersections”, while secure, covered cycle parking facilities will be provided at key destinations (CERA, 2012a). This lack of detail for improving cycling infrastructure does not provide strong encouragement for cycling and represents a large missed opportunity to encourage cycling as a mode of transport. In Christchurch, due to the flat topography, cycling has the potential to be a hugely popular and effective mode of transport. This was noted by an Academic who comments:

Christchurch has a good cycling culture despite the cycle infrastructure rather than because of it. Which makes you think, if you actually put good infrastructure in...you could have lots of people cycling ‘cause you’ve got great geography to cycle (Interview 12).

To increase cycling, the Blueprint plans should nominate cycling priority streets and provide signage to direct cyclists off main traffic routes. The plans should also describe a fully segregated cycle lane design and cycle network design and designate significant funds to its implementation. As they are, the Blueprint plans will not achieve a reduction in CO₂ emissions from land transport through the encouragement of cycling.

6.3.4 Street layout and city design evaluation and matrix

The Blueprint plans have been evaluated against the 32 criteria relating to the street layout and city design variable outlined in the adapted urban design matrix (see table 6.3, below). This evaluation finds that 22 criteria (69 per cent) have been met by the plans and the key projects used for the street layout and city design variable are the Main Streets project, Anchor projects, the grid street pattern, the Frame, the Avon River Park, and the Square. Impressive urban design for the Main Streets project and the Avon River Park should provide better walking facilities in

the central city which should encourage increased use of this alternative mode of transport to the private car. The placement of the key facilities (the Anchor projects) and the retaining of the Square (formerly Cathedral Square) also assist in meeting the criteria for this variable.

However, several opportunities have been missed including the chance to convert all one-way streets to two-way, to further increase connectivity through providing laneways, and to improve cycling infrastructure. It is uncertain how cycling infrastructure will be improved and how much budget will be provided on this aspect. These reasons have resulted in the Blueprint plans not meeting six criteria and only partially meeting four criteria. The Blueprint plans do not compare favourably with the draft central city redevelopment plans for this variable, as the one-way to two-way proposal and the laneways initiative would be implemented by the draft central city redevelopment plans.

Table 6.3: Adapted urban design matrix showing street layout and city design criteria

Design criteria	Urban Villages Forum	Congress for the New Urbanism	Blueprint plans for the central city	Draft central city redevelopment plans	Justification
PHYSICAL FORM CRITERIA					
Integration with Region					
The region provides overall order; the neighbourhood, district and corridor are organising elements; and the assembly of streets/blocks/buildings determine form		●	~	✓	The grid street pattern will remain to provide excellent connectivity, but missed opportunity to further enhance through one-way conversions and laneways
Layout					
Close grained but clear layout of streets, spaces and buildings	●		✓	✓	The grid street pattern
Roads and buildings centre on a public space	●		✓	✓	The Anchor projects and the Square
Central public space is the social heart and focus of commerce/culture/governance	●	●	✓	X	Anchor projects
Streets, lanes, walk ways and public spaces are user friendly, clear and easy to follow	●		X	✓	Laneways project not prioritised

Relates to topography, preserving natural features	●	●	✓	✓	Avon River Park
Walking is encouraged	●	●	✓	✓	Avon River Park
Cycling is encouraged	●	●	X	~	No detail provided on improving cycling infrastructure
Uses with high vehicle dependence are located near the edge	●		✓	X	Anchor Projects The stadium, hospital
Street vistas are important		●	✓	✓	Main streets project
Design favours human scale		●	✓	✓	Main streets project
Ensures there is a public realm		●	✓	✓	Anchor projects, Avon River Park, the Square and the Frame
Public open-spaces are designed to be inhabited, not solely viewed		●	✓	✓	The Frame, Avon River Park and the Square
Public facilities are spread throughout	●		✓	✓	Anchor projects, The frame and the Avon River Park
Blocks are relatively small, with parkway, sidewalk and setback on their periphery		●	X	✓	Laneways to increase permeability are not prioritised
Roads are safe, interesting and comfortable for pedestrians		●	~	✓	Main streets project achieves this criteria, but reduced one-way conversion does not help to achieve
Roads are part of interconnected networks	●	●	✓	✓	Grid street pattern
Roads provide a clear pattern with a central point of focus	●	●	✓	✓	Grid street pattern, the Square
Roads are arranged hierarchically		●	✓	✓	Grid street pattern
Traffic calming measures and low speed geometries tame motoring manners	●	●	~	✓	Main streets project, could have further enhanced this through one-way conversion
Block layouts provide a maximum number of entrances and exits for pedestrians and cars	●		X	✓	Not all one-way streets converted, so maximum number of entrances and exits not achieved
On-street parking can be used to	●	●	✓	✓	Main streets

protect pedestrians from danger of moving traffic, especially on-street chevron/angle parking in the middle of blocks					project
Pedestrian Priority					
Walking is a realistic choice	●	●	✓	✓	Avon River project
Cycling is a realistic choice	●	●	X	X	No detail on improving cycling infrastructure
Traffic calming measures extend and enhance the area of pedestrian primacy	●	●	~	✓	Main streets project
Short, direct walking routes exist through or between buildings	●		X	✓	Laneways not prioritised
Wide sidewalks, shade trees, and buildings close to the street		●	✓	✓	Main streets project
Architecture and Design					
Buildings, spaces, paving, planting, and street furniture are attractive and reassuring	●		✓	✓	Main streets project
The central public space is pleasant to use, environmentally friendly, well lit, with high standards of design and construction	●		✓	✓	The Square
Large important buildings occupy key sites	●	●	✓	X	Anchor projects
SOCIAL AND COMMUNITY CRITERIA					
The central public space is shared, safe and accessible and community facilities and services are provided to enrich communal quality of life for all peoples and lifestyles. This creates a sense of community and encourages people to use this space	●	●	✓	✓	The Square
Prominent siting of civic buildings and public gathering spaces reinforces community identity and a culture of democracy	●	●	✓	X	Anchor projects
Key: ✓ meets criteria X does not meet criteria ~ partially meets criteria ● criteria endorsed by urbanist group					

6.4 The provision of sustainable public transport: Light rail transit

There is one main initiative from the draft central city redevelopment plans that provides sustainable public transport within the central city: the proposed light rail transit (LRT) project. As discussed in section 5.4, the LRT proposal was removed from the Blueprint plans.

In the draft central city redevelopment plans, a significant section was devoted to a LRT proposal. During the significant public consultation that occurred (refer section 4.4), many residents of Christchurch wanted to see how LRT could be integrated

into the transport system for the city; however there was also concern over the cost (CCC, 2011). As noted in chapter five, interview participants were concerned about the implications for the wider transport network (Interview 4, 8a, 8b), which had not yet been explored prior to the draft central city redevelopment plans' release. The draft central city redevelopment plans outlined how investment in LRT could assist in the earthquake recovery of the city, as many cities, such as Portland, Shanghai, and Vancouver, have used light rail to revitalise urban areas and stimulate the economy. Urban Academics, such as Cervero (1984) and Newman et al. (2009), agree with this hypothesis, while Newman (2012) argues that value capture from property rate increases near rail investment can offset some of the initial capital outlay of rail projects. An Academic reinforces these points by commenting:

One of the things about rail is that it very much shapes your urban development as well...you know that the land value will go up when you put a rail line in, and what you do is you implement a way of capturing that increased value of the land to pay for the rail corridor. So, for instance, you'd get it through rates or something. So if you know that the land value will go up between 15 per cent, 20 per cent...the increased value of that land pays for the rail project. It will never work with bus because buses move and you can move the bus corridor, but with rail it's a pretty permanent corridor so people will invest in it (Interview 12).

The draft central city redevelopment plans suggest that LRT can often have "a transformational effect on a city's image, helping to generate business growth and confidence as a consequence, while improving the quality of life, city vitality and community health and wellbeing" (CCC, 2011, p. 109). A Local Government Official agrees with this statement and argues that

One of the reasons for really looking at rail was to encourage regeneration and stimulation of economic growth...if you just look at it as a transport solution, we're gonna struggle to mount a case that that can be justified, but if you look at the regeneration potential and the economic growth potential

that has occurred in other cities around the world, then yeah, there is a much more stronger argument for moving to rail (Interview 3).

Another Local Government Official agrees and states “The possible benefits of light rail are that you can actually change land use...transform bits of the city through the use of the light rail corridors, it’s been demonstrated overseas” (Interview 4). Similarly, another Local Government Official comments:

Clearly that has an impact both in terms of transport, that we can move people around the city, but actually it also has an impact on the urban form that builds up around the rail network and that’s been observed all over the world where you have the certainty of that public service. If you have a bus line or a cycle lane, whatever, you don’t get certainty for the developer...but if you put a rail system in, it helps drive the urban form that we’re looking for (Interview 5).

However, despite the CCC’s recognition of the many benefits of LRT and international precedents and research, the Minister decided that more assessment as to the implications on the wider transport network was needed (Brownlee, 2012). A Central Government Official agreed with this and comments:

I think the first question when you talk about commuter rail out to [Waimakariri], Rangiora, Rolleston, those sorts of areas, is that really about recovery of the CBD? So is that getting beyond the ambit of what they’re supposed to be looking at?...those sorts of things are incredibly complex pieces of work...particularly light rail...so it raises a whole lot of questions that can’t be answered within the high level overview that you’re doing for a recovery plan (Interview 8a).

Similarly, another Central Government Official states:

So the light rail’s a lovely idea, but it just doesn’t stack up as a priority, particularly the model that was in there...and there’s that other issue I talked about in terms of effects on the wider network (Interview 7).

This highlights a large difference between the Blueprint plans and the draft central city redevelopment plans. The LRT proposal offers obvious transport benefits at low emissions. Additionally, the LRT can combine with the other sustainable urban design variables, such as increased density and mixed-use development, to change land-use and drive desirable patterns of urban development.

6.4.1 The provision of sustainable public transport evaluation and matrix

Table 6.4, below, outlines the provision of sustainable public transport criteria from the adapted urban design matrix. As shown, the Blueprint plans will meet only two out of 11 criteria, due to the centrally located bus exchange and the provision of public transport super-stops. Super-stops provide better weather protection and better transit information for public transport passengers, and are located near major facilities (e.g. the hospital), have excellent pedestrian access, as well as providing cycle parking facilities. The Blueprint plans will partially meet one criterion and will not meet eight criteria relating to this variable. This is largely due to the decision to set aside the LRT proposal, which offered an environmentally sustainable and innovative transport solution. This highlights a large difference between the Blueprint plans and the draft central city redevelopment plans. From the adapted urban design matrix it can be seen that the original draft central city redevelopment plans would meet 10 criteria due to the LRT proposal. It is for this reason that the Blueprint plans compare very unfavourably with the draft central city redevelopment plans. From the above analysis it is clear that the redevelopment plans for the central city of Christchurch will not achieve a reduction in CO₂ emissions from land transport due to the lack of provision of sustainable public transport.

Table 6.4: Adapted urban design matrix showing the provision of sustainable public transport criteria

Provision of sustainable public transport criteria	Urban Villages Forum	Congress for the New Urbanism	Blueprint plans for the central city	Draft central city redevelopment plans	Justification
PHYSICAL FORM CRITERIA					
The Site					
Capable of good transport links	●		✓	✓	The bus exchange is centrally located
Close to a railway line and station	●		X	✓	The LRT

					proposal has been set aside
PUBLIC TRANSPORT					
Provides an attractive alternative	●		X	✓	LRT proposal set aside
Efficient, with traffic management giving it priority over other vehicles	●		X	✓	LRT proposal set aside
Direct and logical		●	X	✓	LRT proposal set aside
Frequent, predictable, and economically viable		●	X	✓	LRT proposal set aside
Links with the region	●	●	X	✓	LRT proposal set aside
Use of transit is encouraged and facilitated	●		~	✓	Public transport is encouraged but not facilitated as the LRT proposal has been set aside
Transit stops are clear, easy to use, safe, dry, and dignified	●	●	✓	~	Super-stops provided for in Blueprint plans
The public sector commits to funding major transport infrastructure	●		X	✓	LRT proposal has been set aside
ECONOMIC CRITERIA					
Sustainability					
Public sector financial commitment ensures provision of infrastructure and services	●		X	✓	Government not investing in LRT proposal
Key: ✓ meets criteria X does not meet criteria ~ partially meets criteria ● criteria endorsed by urbanist group					

6.5 Summary

The Blueprint plans have been evaluated against a total of 63 criteria relating to the sustainable urban design variables of increased density, mixed-use development, street layout and city design, and the provision of sustainable public transport. Overall the Blueprint plans will meet 37 criteria (59 per cent), partially meet ten criteria (16 per cent), and will not meet 16 criteria (25 per cent). This demonstrates that in terms of the variables of sustainable urban design, that it has been established do reduce CO₂ emissions from land transport, will only be implemented to a varying extent and with varying success.

From this evaluation it can be seen that the Blueprint plans are likely to be successful in achieving increased density within the central city, as 81 per cent of criteria are met. However perceptions from interview participants contradict these results. The matrix criteria are very specific and the redevelopment plans can meet

these criteria simply by allowing residential activity within the central city. Data from interview participants is more nuanced and shows less optimism that the redevelopment plans will be successful due to the permissive nature of the RMA planning regime that does not enforce the implementation of desirable planning rules. Interview participants comment that implementation is difficult; furthermore there is no political willingness to provide for more directive planning.

The same reasons for differences between the matrix evaluation and interview participants' comments apply to the mixed-use development variable; although the matrix evaluation better aligned with interview participants. The matrix determined that this type of development is unlikely as 66 per cent of the criteria are only partially met.

In terms of the street layout and city design variable, the evaluation show that the Blueprint plans will meet 69 per cent of the criteria; however several key opportunities have also been missed. These include not enhancing connectivity in the central city by converting all one-way streets to two-way, and not prioritising the laneways initiative. Furthermore, no detail or budget has been provided for improving cycling infrastructure which signals a disregard for encouraging this form of transport despite favourable topography and cost-effectiveness. It is difficult to reflect these missed opportunities in the matrix style evaluation.

The matrix and the interview participants are in agreement when evaluating the provision of sustainable public transport variable. It is clear that the Blueprint plans will not be successful in achieving a reduction in CO₂ emissions from land transport through this variable because of the set-aside of the LRT proposal. Data from interview participants establishes that the main barrier to implementing this sustainable urban design variable is cost. The next chapter will discuss in more detail the barriers associated with implementing sustainable urban design.

Chapter 7 Barriers to implementing sustainable urban design

As demonstrated in chapter six, the Blueprint plans for the redevelopment will not meet all the criteria of best practice sustainable urban design to reduce CO₂ emissions, as the four variables will be employed to varying extents and with varying success. The question why the Blueprint plans have failed to meet international best practice needs to be asked. This section will answer research sub-question three (what barriers exist to implementing sustainable urban design variables to reduce CO₂ emissions from land transport in the redevelopment of Central Christchurch?) using participant interview data and insights from literature to highlight barriers to implementing sustainable urban design. Some barriers and implementation difficulties of sustainable urban design in NZ have been previously identified by DIA (2008) (described in table 7.1, below).

Table 7.1: Barriers to implementing sustainable urban design in NZ

Barriers to implementing sustainable urban design
1. Lack of capacity and capability across government and development industry
2. Limited co-ordination across planning levels (i.e., national, regional, local) for large scale urban development
3. Ineffective integration between land use and transport planning
4. Difficulties assembling useful parcels of land from fragmented groups of properties, or in buying and/or ensuring appropriate development of strategic sites
5. Public resistance to urban intensification

Source: DIA (2008).

These barriers emerged from NZ-based research from the *Building Sustainable Urban Communities* report developed by DIA after public consultation. As such it provides a useful starting point for the barriers discussion within the current study. However, barrier four in table 7.1 can be disregarded in relation to the redevelopment of Christchurch, as central city devastation has ensured that landowners are willing to sell. Furthermore, the CERA legislation (refer section 4.3) provides the power for compulsory purchasing if required. Barrier five can also be disregarded as wide public consultation helped to inform the CCC's draft central city redevelopment plans, which has limited any public resistance. The first three

barriers can be re-grouped into themes of lack of communication and co-ordination, short timeframes, and lack of leadership and vision.

These barriers have been reinforced by the findings of the New Zealand Council for Infrastructure Development (NZCID, 2010) report. This report compared infrastructure development and planning processes in several countries and noted that NZ lacked strong leadership and a long term vision. These were keys to success in other countries such as Denmark. This report also suggests that inconsistent cohesion between planning levels and vision in NZ is due to the decentralised planning system, while decision-making on key infrastructure issues, such as sustainable transport, needs more alignment between local and Central Government (NZCID, 2010). This lack of alignment or co-ordination between planning levels (e.g., Central and Local Government) is discussed in more detail in the following section.

7.1 Lack of communication and co-ordination

The communication and co-ordination between planning levels has emerged as a barrier to implementing sustainable urban design variables to reduce CO₂ emissions from land transport in the redevelopment of the central city of Christchurch. Initially the responsibility for the redevelopment of the central city was to be administered by Local Government, who conducted a large public consultation campaign (refer section 4.4), from which sustainability emerged as a key theme. A large public response gave the CCC a powerful mandate to promote an innovative sustainability approach, including urban design measures to reduce CO₂ emissions from land transport. Interview participants agreed that the public consultation and response were excellent, as presented in table 7.2, below.

Table 7.2: Interview participant quotes regarding the public consultation process

Theme	Quote
Engagement and input by community	They got a huge message from their community: ‘you haven’t been listening to us.’ And then they took the bull by the horns, and yes, on that central city plan the input from the public was enormous (Interview 1, Local Government Official).
	The consultation was broad, it was long, it was wide, and the city council

	down there are to be commended (Interview 11, Academic).
	The Share An Idea thing was stunning. Getting 107,000 ideas out of a population of just over 300,000 people is amazing, and it actually makes it very difficult for the Government to turn around and say, we don't like it (Interview 12, Academic).
	When you get 107,000 out of 300,000 people, that's pretty clear that the people have spoken, and they were pretty clear what they wanted. They wanted a futuristic city and they wanted active transport, and they talked about light rail and they talked about cycling and green roofs and low buildings...I've never in this country seen...people feeding into a process so strongly and so powerfully (Interview 12, Academic).
Green city mandate	And we got a hugely resounding support for the green city theme. It was so important to the residents of Christchurch...incredibly strong, and in fact they went beyond what we would have done ourselves...so that gave us the confidence to really step out in our planning and put some really innovative things forward (Interview 5, Local Government Official).
	That essentially came through from 105,000 submissions or comments from the public. So that was pretty clear that that was what the public wanted (Interview 8a, Central Government Official).
Good urban design	They're [the public are] quite keen to see good urban design outcomes and that came through very strongly in the Council's Share An Idea and Tell Us What You Think campaigns, which led to the development of the draft recovery plans (Interview 6, Local Government Official).

Despite broad commendation and widespread public support for their approach, the CCC was replaced by the Central City Development Unit (CCDU) of CERA to oversee central city redevelopment. This forced Central and Local Government to work together, and highlighted several redevelopment process issues. The Blueprint plans had not been released at the point in time when the interviews for this research were conducted, so there was some understanding among interview participants that certain confidential or sensitive issues could not yet be discussed by Central Government (Interview 6, 10). However, several communication issues emerged through the interviews.

Many interview participants believe that communication between Central Government and Local Government has been insufficient (Interviews 1, 6, 9, 10, 12).

Local Government Officials interviewed have felt that communication from Central Government could be much better. For example:

I don't see a partnership approach at this point...I don't think the amount of communication that I am aware of that occurs is sufficient to manage recovery at a partnership basis between all the agencies (Interview 6).

Another Local Government Official comments "I have weekly meetings with CERA officials, I don't think I really know what is going on in terms of earthquake recovery" (Interview 1). Some interview participants felt that the governance structure of the redevelopment was confusing with many different types and numbers of organisations and departments with different responsibilities (Interview 1, 11, 12). An Academic interviewee highlights this confusion by commenting:

We have a city council, we have a regional council, we now have a Central City Development Unit. We have a Minister for Economic [*sic*] Recovery, we have CERA, we have Boffa Miskell. I don't think anyone knows [who is responsible]. Dare I say that's the problem? (Interview 12).

A Central Government Official concedes "it's a complex web of groups and committees" (Interview 8b) that is involved in the redevelopment. Local Government Officials also felt that if communication was occurring it was happening at the wrong levels between organisations (e.g., occurring between upper management but not at less senior levels) (Interview 1, 6). Another Local Government Official highlights the differences between organisations by commenting:

One issue is that CERA is a government department. Government departments operate differently to local authorities...with a Government department it's very much top-down...the Minister and the Minister's office issue instructions to the government department and to the officials, and when those officials report back to the Minister, it's very much kept secret until the Minister announces that something is to happen...so it's meant

difficulties in terms of local authority officers and CERA officers working as a complete team (Interview 1).

A Central Government Official acknowledged that “It’s not always an easy mix ‘cause we do have different...goals that we want to achieve in some instances” (Interview 8a). Another Central Government Official suggests that funding conversations were required from Local Government, who needed to:

Actually have those good conversations with Central Government rather than going, ‘hey, we’ve got this great idea, let’s put it in our plan’ and then expecting Central Government to go, ‘oh yes, it’s great, let’s go for it’ (Interview 9).

The adapted urban design matrix also contains process and public involvement criteria, which authors such as Edgington (2010) and Thompson-Fawcett and Bond (2003) consider important in urban design and disaster recovery. Table 7.3, below, evaluates and compares the two redevelopment plans and shows that the Blueprint plans compare unfavourably to the draft central city redevelopment plans in this aspect. The Blueprint plans will only meet one criterion, due to the public/private partnerships in the Residential Demonstration project, while the draft central city redevelopment plans will meet all eight criteria.

Table 7.3: Adapted urban design matrix showing the process and public involvement criteria

Process and public involvement criteria	Urban Villages Forum	Congress for the New Urbanism	Blueprint plans for the central city	Draft central city redevelopment plans	Justification
PROCESS CRITERIA					
Planning Process					
Public/private sector partnership	●		✓	✓	Residential Demonstration project achieves private/public partnership
Local Government endorses community design and urbanist principles		●	~	✓	Urbanist principles identified in CCC draft redevelopment plans: some, but not all transferred to Blueprint plans
Citizen-based participatory		●	X	✓	Share-an-idea

planning and design					and workshops were great for the CCC, but no on-going public communication by CERA
Early community involvement	●		X	✓	Share-an-idea and workshops
Positive, genuine, timely and credible participation involving such mechanisms as market research, in-depth interviews and dialogue, 'Planning for Real' or public planning workshops and on-site charettes	●	●	X	✓	Share-an-idea and workshops
A range of local groups, organisations, professionals and community leaders is involved	●	●	~	✓	Share-an-idea and workshops
The public is kept updated and informed of consultation outcomes	●	●	X	✓	Share-an-idea and workshops
Public involvement is a continuing process	●		X	✓	Share-an-idea and workshops
Key: ✓ meets criteria X does not meet criteria ~ partially meets criteria ● criteria endorsed by urbanist group					

7.2 Short timeframes

Another barrier during the process of the redevelopment of the central city of Christchurch has been the short timeframes imposed on the redevelopment by Central Government. The long-term nature of the built environment means that decisions made now for the redevelopment of the central city of Christchurch will affect the future of the city for the next 50 to 100 years or more. Given the importance of the decisions to be made, interview participants have commented that the timeframes provided are too short (Interview 3, 7, 9, 10, 11), with the Central Government imposing a 100 day timeframe for the creation of the Blueprint plans. A Central Government Official, citing disaster recovery research, is concerned:

Italy was probably the worst...they built these great big huge multi-storey apartment complexes and whacked them in willy nilly anywhere. And then they said, 'oh, we've done- we've spent the millions. That's it, here it is.' You don't want that, because that's the sort of thing that would...happen if you have that really short timeframe, and we've got to spend our money...you've

only got three years to get stuff done, and how are you going to get it done within that timeframe? (Interview 9).

Further questions need to be asked whether proper process can be followed in the timeframes provided. An Academic is concerned that the outcome will be low quality decisions being made:

What worries me is not so much the tight timeframe in itself, but the amount of time that that allows for discussion, debate, consultation. And it seems to me that by prescribing this 100-day period...is that it will potentially reduce the robustness of the decisions that are made, because it won't allow for proper consultation (Interview 11).

The Government has also focussed on kick-starting the redevelopment, as highlighted by a Local Government official who comments:

The longer it takes, the more there is uncertainty in the wider community and the development community around the shape and speed of recovery. And we also know that if recovery has slowed in the first three years then the recovery long term is much longer. It's really important to act quickly within those first three years and so the Government is doing that (Interview 6).

A tension is developing between Local Government, who have taken a long-term, high quality stance, and the Central Government, whose view is that the city needs to return to normal as quickly as possible, with the main focus on economic recovery. A Local Government Official highlights this issue by commenting:

The Council...was focussed on long-term recovery...it [the plan] was about the long-term built environment and overall long-term recovery. The timeframes within other organisations may not be as long (Interview 6).

From an urban design perspective, an Academic interviewee is undecided about the speed of the redevelopment:

On the one hand I think it's good, because it would be too easy for the city...to settle into a pattern of being a donut. So, on the one hand I think they need to push ahead. On the other hand it took 150 years to build the city pre-earthquake, what's the hurry to reinstate it? (Interview 11).

Undesirable redevelopment patterns have already emerged with long-term leases being signed in the outer suburbs such as Hornby and Riccarton (Interview 7). An Academic is concerned that this will occur on a larger scale through:

Property owners who may have private insurance settlements will be taking their money elsewhere and...there will be nothing left with which to develop the central city (Interview 11).

Part of the reason to establish the key anchor projects early in the redevelopment was to show where those anchor tenants, such as government departments, will be located, and once they return to the central city, other professions which rely on the anchor tenants will also relocate back into the central city to be close by (Interview 2, 7).

7.3 Lack of leadership and vision

Another barrier to implementing sustainable urban design variables to reduce CO₂ emissions from land transport in the redevelopment of Christchurch is leadership. Olshansky, Johnson, & Topping (2005) found that leadership is a critical success factor in disaster recovery processes. Their analysis of earthquake recovery in Los Angeles and Japan noted that local level leadership is often more effective than Central Government leadership due to local knowledge. Governance and leadership can affect urban form as planning policies at the regional, city and local levels have a great effect on the size, shape, density and layout of development and the type of land use allowed (e.g., industrial, residential) (Banister, 2005). A lack of vision and experienced leadership in the public sector has also been cited by Witten and Abrahamse (2011) as a barrier to implementing residential intensification in NZ.

In March 2011, Gerry Brownlee was named Minister of Earthquake Recovery and tasked with the responsibility to lead the redevelopment of Christchurch. An Academic questioned whether Minister Brownlee was the right person for the job

(Interview 12), while several interview participants criticised the Government for a lack of vision, especially in regard to sustainability and climate change within the redevelopment of the central city of Christchurch (Interview 1, 5, 7, 9, 12). In particular, a Central Government Official comments that Minister Brownlee has:

Told us to be innovative...but his idea of innovation might be quite different to someone else's idea of innovation...he's really excited about urban spaces and green spaces, but I'm not sure that he understands the implications of those things and what it means for the speed of recovery (Interview 7).

Another Central Government Official also highlights further weaknesses in Minister Brownlee's approach by stating:

I'd have to say that Gerry Brownlee, from what he's done, is good but he's not a collaborator...You've got a Minister that's only just starting to really collaborate with his other officials, his Government, his other Cabinet colleagues and things, so yeah, so that's [collaboration/communication] going to be an on-going issue (Interview 9).

It is interesting that both of these interview participants are Central Government Officials.

This lack of leadership extends to a lack of political will to implement sustainable urban design variables to reduce CO₂ emissions from land transport in the redevelopment of the central city of Christchurch. According to Newman (2004, p. 612), taking political risk is necessary in order to create gains for sustainability and visionary leadership is essential as sustainability 'in its most fundamental form is about long-term futures'. Through the interviews for this research it emerged that NZ's political cycle (which lasts three years) inhibits the approval of high quality, long-term decisions (Interview 5, 7, 12). A Central Government Official explains how political cycles determine the priorities of Central Government agencies as the Government of the day sets out its priorities in the Government Policy Statement (GPS) on land transport and it is up to the government agency to interpret and give effect to that policy through the policy documents that it creates (Interview 8a).

This is especially evidenced in transport initiatives, where the majority of funding is spent on roading to meet current demand (Interview 3), rather than future-proofing the nation against the implications of climate change and peak oil. This can be seen through the rejection of the LRT proposal in Christchurch, which, although ambitious, was looking to the future as a method to meet transport needs and influence the land-use patterns of the city (Interview 5). An Academic laments the situation in NZ:

I think we are lagging. Part of it is we don't seem to have visionary leaders I'm afraid...We seem to have some fairly old-fashioned people in fairly important positions who still think road building is the way to go in Christchurch. The transport plan that's just come out includes investigations for another big motorway thing and it just drives me to despair (Interview 12).

A Local Government Official highlights the lack of vision of the current government and its mindset:

The Government, basically, controls the purse strings and their focus is around economic development through roads of national significance, linking ports to origins and destinations...that's largely determined by the fact that the government policy statement on land transport funding largely sets the direction and at least in the current GPS, the next 10 years is signalling no greater investment in walking, cycling, public transport...But I think even beyond the 10 years I think it's likely that this government isn't going to start to put a lot more money into those other modes (Interview 2).

There is a concern among interview participants that the redevelopment will be a "quick-fix" (Interview 10) and issues of climate change and urban sustainability will be overlooked due to the ideals and the lack of vision of the Government of the day. The current Government is averse to sustainability to the point of removing the word from policies (Interview 5), although the community of Christchurch has overwhelmingly supported redevelopment in an innovative and sustainable way. This begs the question: For whom is Christchurch being redeveloped? Is it for the

people of Christchurch, or is it for the Government and Gerry Brownlee? Disaster recovery experts have often questioned why opportunities to enhance urban space following disasters are infrequently capitalised on, and also question whose vision for the future gets realised during redevelopment (Edgington, 2010; Vale & Campanella, 2005). Edgington (2010) urges planners and governments to take advantage of these rare opportunities to enhance urban space and make large-scale improvements to infrastructure, transport, and facilities, which have long term implications due to the timeframes involved with the lifecycle of buildings.

7.4 Summary

This thesis has underlined the opportunity to redevelop the central city of Christchurch using sustainable urban design. Through extensive public consultation it has been established that the residents of Christchurch also want a sustainable city. Nevertheless, as shown in chapters five and six, an overall sustainability outcome is unlikely to be achieved. It begs the question: why?

This chapter answered research sub-question three (what are the barriers to implementing sustainable urban design?), using data from literature and interview participants to highlight three barriers; lack of communication and co-ordination, lack of leadership and vision, and short timeframes. These barriers are all associated with the Central Government, who have been criticised for their top-down planning process and poor communication with Local Government and the public. The leadership of the redevelopment has removed the responsibility from Local Government and altered plans which originated from extensive public consultation. Their refusal to include desirable redevelopment features, such as LRT, shows a reluctance to change and innovate, even when provided with a significant mandate from the public to do so.

In the following chapter recommendations will be made to Central Government to overcome these barriers and allow the redevelopment of the central city of Christchurch to be successful in reducing CO₂ emissions from land transport. The following chapter will also conclude the thesis by summarising the key findings and identifying research limitations as well as opportunities for further study.

Chapter 8 Conclusion

This research explored the issue of climate change mitigation within urban development by asking how sustainable urban design variables that reduce CO₂ emissions from land transport feature in the redevelopment proposals for Central Christchurch following the devastating earthquakes. The rationale for the research was established in chapter one, where the alarming trends of climate change and the potential impacts that may ensue were discussed. It was established that given recent rapid urbanisation and the nature of urban forms, emissions in cities are increasing. In particular emissions from transportation continue to increase in cities that are low density and sprawling, and have poor public transport. Therefore, cities present opportunities for climate change mitigation. It is argued that cities can use sustainable urban design to reduce car dependency and VKT, and therefore reduce CO₂ emissions from land transport. Urban design movements, such as the UVF and the CNU, have practically implemented sustainable urban design internationally; unfortunately NZ has been slow to embrace these trends. In order to address these issues three sub-questions were developed:

1. What are sustainable urban design variables to reduce CO₂ emissions from land transport?
2. How are these variables reflected in the redevelopment proposals for Central Christchurch?
3. What barriers exist to implementing sustainable urban design variables to reduce CO₂ emissions from land transport in the redevelopment of Central Christchurch?

As identified in chapter two these questions were addressed through a pragmatic approach, enhanced by using mixed methods involving a comprehensive literature analysis, planning and policy document analysis, and semi-structured interviews with experts. This approach is considered best practice when researching complex, slowly evolving topics, and to draw out a depth of experiences. Once the data had been collected in this manner, a thematic analysis of the content was employed to establish linkages and easily identify emerging patterns across the different data sources.

Chapter three explored literature from a range of disciplines including urban design, planning, sustainability, climate change, and disaster recovery. In synthesising this literature, it is argued that sustainable urban design variables are important for climate change mitigation. Consequently, chapter three answered research sub-question one by demonstrating that four variables within urban design (increased density, mixed-use development, street layout and city design, and the provision of sustainable public transport), are the most important and relevant for this study. Collectively these sustainable urban design variables are proven to reduce car dependency and CO₂ emissions from land transport by reducing the need to travel by private car, reducing the distance travelled by private car, and encouraging alternative modes of transport, such as walking, cycling, and low-emissions public transportation. The question then was, how do these sustainable urban design variables feature in the proposals for redeveloping Christchurch's central city area. Chapter four provides important context to understanding this question.

Chapter four provides a brief outline of the nature of the earthquakes, the extent of the damage they caused, and the legislative framework that has been established to govern the redevelopment process. The chapter establishes important foundations for the discussion of the findings that begin in chapter five.

Chapter five confirms the importance of the four sustainable urban design variables identified in chapter three by using interview participants' perspectives on sustainable urban design as evidence, answering research sub-question one in further detail. Increased density, mixed-use development, street layout and city design, and the provision of public transport are presented by interview participants as sustainable urban design variables that best reduce CO₂ emissions. Interview participants caution that these variables, although effective in theory, are required to work within NZ's permissive planning regime.

Chapter six answered research sub-question two by evaluating the Blueprint plans against an adapted urban design matrix, and combining these results with literature and interview data. This evaluation establishes that the Blueprint plans would achieve CO₂ emissions reductions through the increased density variable. While the

street layout and city design variable was also largely successful, missed opportunities within this variable diminish the possibilities for CO₂ emission reductions. Success was determined to be unlikely in the mixed-use development variable due to implementation issues. The specific projects that will contribute to achieving reduced emissions are the Frame, the Residential Demonstration project, the mixed-use zone, the grid street pattern, the Main Streets project, and the Avon River Park.

However, although the draft central city redevelopment plans included a proposal for LRT, this proposal was not included in the Central Government's Blueprint plans. The Blueprint plans, therefore will not meet the requirements for the provision of sustainable public transport because the LRT proposal was set aside by Minister Brownlee, despite evidence through literature, international examples, and interview participants of the benefits, both environmentally and economically. This rejection represents a lack of vision, and lack of innovation from decision-makers. It was argued that this represents a missed opportunity within the redevelopment and for the people of Christchurch. Several other projects also represent missed opportunities including converting all one-way streets to two-way, and improving cycling infrastructure. In relation to these missed opportunities, interview participants expressed concern that the implementation of the Blueprint plans would not achieve a reduction in CO₂ emissions. Interview participants recognised that both the permissive nature of the RMA planning regime that allows a degree of market freedom in development and a lack of political will to enforce desirable planning rules may constrain the opportunities for sustainable redevelopment in this context.

The barriers highlighted by interview respondents are further discussed in chapter seven. This chapter argues that several barriers, as evidenced from literature and interview participants' data, exist within the NZ context and specifically the redevelopment of the central city of Christchurch. The barriers identified and discussed are lack of co-ordination and communication, short timeframes, and lack of leadership and vision. An evaluation against the process criteria of the adapted urban design matrix, supported by literature, and interview participants' comments

establishes that the top-down approach employed by Central Government is a potential barrier to implementing sustainable urban design within the redevelopment of the central city of Christchurch. It was suggested that a remarkable initial public consultation process run by the CCC degenerated into an authoritarian approach by the Minister and CERA, due to the Central Government's desire to rebuild as quickly as possible for economic recovery as much as community recovery. This begs the question- who is the city being redeveloped for: Central Government or the people of Christchurch?

8.1 Research limitations and further research

As with all research, there were limitations in the research process. Common to many Masters research projects, all elements of research must be included in a year of full time study which can limit the scope and depth of the study. Although this project was undertaken on a part time basis over two years (which had some benefits in relation to the long timeframes of the redevelopment), the timing of fieldwork for data collection was, of necessity, prior to the release of the Blueprint plans by CERA. While this may not have substantially affected the results as interview participants held inside knowledge of these plans; for confidentiality reasons, they were unable to be forthright on certain matters. Their full and frank opinions on the sustainability of the Blueprint plans would have provided a greater depth of material. Nevertheless, it does provide scope for further study that will build on the results of this research.

One area of further study that can be explored is to investigate how the sustainable urban design projects highlighted in this research are implemented practically within the next rebuilding phase of the redevelopment of the central city of Christchurch. This, in turn, could lead to a future study examining and comparing pre and post earthquake CO₂ emissions from land transport in Christchurch to determine if the redevelopment plans have been successful in this respect.

Additionally, an interesting aspect that was highlighted from this research but was ultimately beyond its scope, was the political dynamics that are emerging between Central and Local Government involved in the redevelopment. Central Government

has taken a lead role in the redevelopment, and has taken on the responsibility for urban planning and governance usually reserved for Local Government. The implications of the tension created from this could provide interesting analysis.

8.2 Recommendations

In order for the Blueprint plans for the redevelopment of the central city of Christchurch to fully meet the requirements of each of the sustainable urban design variables identified, it is recommended that decision-makers responsible for the redevelopment adopt the following recommendations, which will work together to increase the residential density within the central city and consolidate urban form.

Recommendation one

Enforce planning rules for mixed-use development within the central city of Christchurch, in order to increase residential density, increase vibrancy, and return the economic hub to the central city. This urban design variable needs to be adopted and enforced in the redevelopment plans and all subsequent city and district planning documents. Due to NZ's permissive planning regime, increasing residential density and mixed-use development is allowed and encouraged. However, enforcing rules requiring new building within the central city to contain a balance of residential, commercial, and retail space would ensure that these desirable variables are practically implemented.

Recommendation two

Adopt a proposal to implement LRT within the redevelopment of Christchurch. It has been determined through literature and international examples that LRT can affect land use and urban form around stations and along corridors. This type of certainty is required in Christchurch following the earthquakes to drive the redevelopment and investment back into the city. Sustainable public transport such as LRT can significantly reduce CO₂ emissions from land transport by providing an alternative to private car travel and can link with the other urban design variables to alter urban space to a more sustainable form.

Recommendation three

Adopt a proposal to convert all of the one-way streets in central Christchurch to two-way streets. Additionally, implement further connectivity in the central city through pedestrian-only laneways, and implement increased traffic calming measures. This proposal would complete the grid street pattern in the central city, allowing increased connectivity for pedestrians, as well as calming traffic. This increased connectivity and calmed traffic would encourage walking as an alternative mode of transport within the central city as key points can be accessed easily. Research shows that traffic calming encourages walking due to increased perception of safety and more pleasant walking experience.

Recommendation four

Allocate a significant proportion of the transport budget of the redevelopment to improving cycling infrastructure within the central city. Cycling should have a higher percentage of mode share within Christchurch due to favourable topography; it currently does not due to poor infrastructure and facilities. The best method to encourage cycling is to increase cyclist safety by developing a network of cycle lanes physically separated from traffic. The physical separation may be in the form of a hedge or fence between cyclists and moving cars, or cyclists can be moved off the road network altogether by creating cycling only paths.

8.3 Conclusion: Seizing the opportunity?

This thesis has argued that there is an opportunity to redevelop the central city of Christchurch using sustainable urban design to reduce CO₂ emissions from land transport. Through the course of the research it has been determined that, although the Blueprint plans contain some desirable features, overall the opportunity will be lost. Unfortunately the political risk accompanying change and innovation, including sustainable urban design, is too great for the current centre-right government despite the obvious benefits emerging from the disaster to create a modern, sustainable city that is resilient to the impacts of future issues such as peak oil.

This thesis focussed on an opportunity for a reduction in CO₂ emissions from land transport; however, many environmental co-benefits arise from this goal including the preservation of open space, decreased air pollution, and reduced building energy consumption. In addition, many social, economic, and health benefits also arise including increased physical activity, increased social interaction, increased sense of community, increased sense of safety, and local employment.

Climate change is the greatest issue facing the world today, and rising emissions from urban areas, including those from transportation, are exacerbating this anthropogenic effect on the climate system. Innovative responses are required within climate change mitigation and sustainable urban design must be seriously considered for widespread implementation in a world becoming increasingly urbanised.

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Appendix one: Human Ethics Committee approval



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Email Allison.kirkman@vuw.ac.nz

MEMORANDUM

TO	Benjamin Speedy
COPY TO	Sophie Bond
FROM	Dr Allison Kirkman, Convener, Human Ethics Committee
DATE	11 April 2012
PAGES	1
SUBJECT	Ethics Approval: 19193 Seizing the opportunity? How will sustainable urban design to reduce CO2 emissions from land transport feature in the redevelopment of Christchurch?

Thank you for your application for ethical approval, which has now been considered by the Standing Committee of the Human Ethics Committee.

Your application has been approved from the above date and this approval continues until 28 February 2013. If your data collection is not completed by this date you should apply to the Human Ethics Committee for an extension to this approval.

Best wishes with the research.

Allison Kirkman
Human Ethics Committee

Appendix two: Sample interview questions



How Sustainable Urban Design will feature in the redevelopment of Christchurch

Sample Interview Questions

- Can you describe your role in the redevelopment of Christchurch and/or urban design in general.
- Do you understand what the key principles of sustainable urban design are?
- Do you think the planned redevelopment of Christchurch represents international best practice of sustainable urban design?
 - If not, why, in your opinion, was it not planned to meet international best practice? What principles/issues/factors did influence the creation of the redevelopment plan?
- What do you think could have been achieved/better in terms of sustainability?
- What are the barriers to implementing sustainable urban design variables?
- What other factors compete with sustainability when creating a redevelopment plan after a major natural disaster? How significant a factor is sustainability?
- How much does the pressure to return to normal as soon as possible affect redevelopment?
- How well does the plan reflect public submissions obtained through the public consultations such as 'Share an idea'?
- Do you think the public participation exercises were suitable?
- How was the redevelopment plan created? What were the processes that were followed?
- How much does legislation and policy guide the creation of the redevelopment plan?

- How much do planners/Urban Design Professionals take into consideration national strategy documents such as the NZ urban design protocol when creating city plans and/or designing urban space?
- Do you think it's important for urban designers/planners to consider the impacts of, and adaptation to, climate change when creating plans and designing space?
- Are you aware of any sustainable urban design variables to reduce CO₂ emissions from land transport? Which of these variables are the most suitable for the redevelopment of Christchurch?
- Was reducing CO₂ emissions a priority when creating Christchurch's redevelopment plan?
- Do you think that the Christchurch earthquake is an opportunity to showcase the latest sustainable urban design variables and to create a sustainable, liveable, competitive, green city which will be a world leader and showpiece of sustainable urban design to reduce CO₂ emissions from land transport and for other environmental/sustainable ideas

Appendix three: Information sheet for interview participants

VICTORIA UNIVERSITY OF WELLINGTON
Te Whare Wananga o te Upoko o te Ika a Maui



How Sustainable Urban Design will feature in the redevelopment of Christchurch

Information Sheet for Interview Participants

Thank you for your participation in this research. Please read this information sheet before your interview.

Researcher: Benjamin Speedy, School of Geography, Environment and Earth Sciences

I am a Masters student in Environmental Studies at Victoria University of Wellington. As part of this degree I am undertaking research leading to a thesis.

The research is being conducted to gain an understanding of how techniques of sustainable urban design will feature in the redevelopment of Christchurch particularly to reduce CO₂ emissions from land transport. This research aims to explore how and why key decision-makers have made decisions on Christchurch's redevelopment and to what extent sustainable urban design techniques to reduce CO₂ emissions feature in those decisions. I will be interviewing a range of people who are involved in decision-making and planning of the redevelopment as well as urban design, planning and government officials.

Interview Format

This interview will take approximately 30 – 60 minutes of your time and will be audio recorded. It is based on a semi-structured format so the exact nature of the questions have not been determined in advance but will depend on the way that the interview develops. Should the line of questioning progress in a way that makes you uncomfortable you can decline to answer any question(s) at any stage. You may, at any time, request statements to be off the record and/or have the recorder turned off at any time during the interview

Participation

Your participation is completely voluntary and you can leave the interview at any time and may withdraw from the study by 31st December 2012.

Data Use and Storage

The data collected will be securely stored in such a way that only the researcher and the researcher's university supervisor will be able to gain access to it. At the end of the project any personal information will be destroyed immediately, except that on which published results rely. These data will be stored securely for a period of five years.

It is intended that one or more articles will be submitted to scholarly journals and that the research may form the basis of conference presentations or further funding applications. You may receive a final report with the findings if you wish (please indicate on the consent form). You may also receive a copy of any interview transcript if you wish.

The opinions, views and statements recorded during the interviews will only be used for the purposes of this research project, plus any scholarly journal articles or further research funding applications that may result. All opinions, views and statements made by you will be attributed in the final report to a pseudonym. The pseudonym will represent the position you hold in relation to the redevelopment of Christchurch (e.g., Planner, Urban Design Professional).

This research has been approved by the Human Ethics Committee at Victoria University of Wellington.

If you have any further questions at any time, please contact Benjamin Speedy (details below). Thank you for taking part.

Benjamin Speedy

speedybenj@myvuw.ac.nz

022 677 9845

Sophie Bond (Supervisor)

sophie.bond@vuw.ac.nz

04 463 5217

Appendix four: Consent form for participants

VICTORIA UNIVERSITY OF WELLINGTON
Te Whare Wananga o te Upoko o te Ika a Maui



How Sustainable Urban Design will feature in the redevelopment of Christchurch

Consent Form

I have read and understood the information sheet and I understand that I can request more information at any stage.

I understand that every effort will be made by the researcher to protect my identity; however some participants may be identifiable to close acquaintances due to the nature of their comments. I am aware that a pseudonym will be used to represent my opinions in the final write up of this information and consent to this.

Yes / No

I am aware that participation is purely voluntary and I can withdraw at any time, refuse to answer any questions, or retract any statements before 31 December 2012.

I am aware that I can request statements to be off the record and/or have the recorder turned off at any time during the interview.

I understand that the information I give will not be used for any purpose other than those listed below and outlined in the information sheet without my consent.

I understand I will have the chance to check the transcripts prior to publication and make any comments.

I understand that data collected will be securely stored in such a way that only the researcher and the researcher's supervisor will be able to gain access to it. At the end of the project any personal information will be destroyed immediately, except that on which published results rely, which will be stored securely for a period of five years.

I would like to receive a copy of the interview after it has been transcribed:

Yes / No

I would like to receive a final report of the findings at the conclusion of the research: **Yes / No**

If yes, my postal address is:

And my email address is:

I, _____ consent to being interviewed and audio recorded by Benjamin Speedy for the purposes of the research project and producing one or more journal articles, and presentations at conferences or further funding applications.

Signed

Date
