Christchurch City Council
Development Contribution Policy Growth Model

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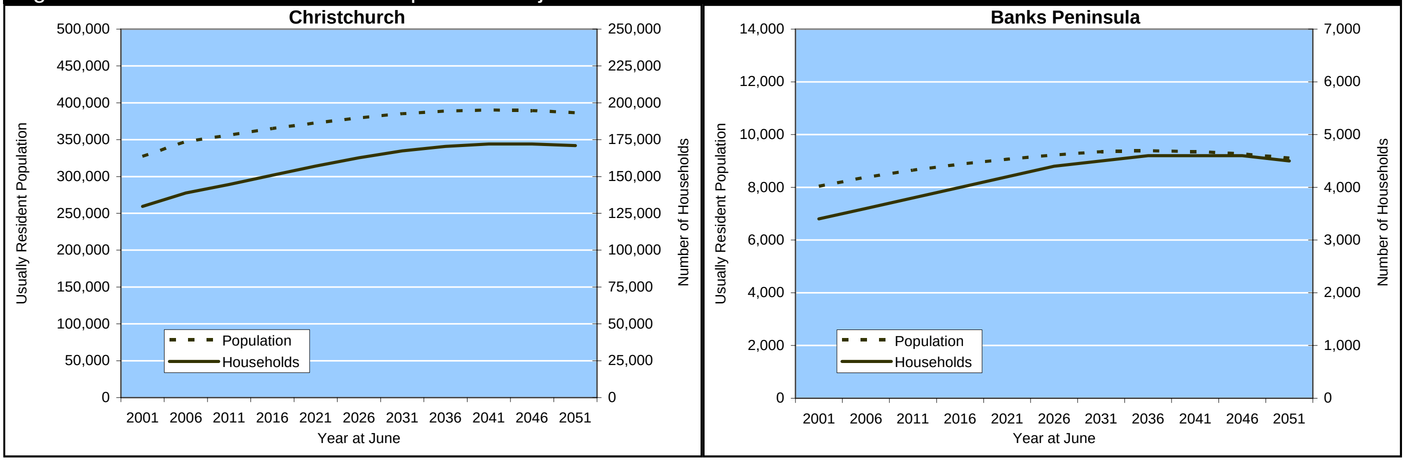
Contents

Introduction

This report provides a summary of the processes used to develop the Growth Model and it's three components: Household; Business and Impervious Surfaces, for the Christchurch City Council's Development Contributions Policy. The report's structure is separated out into the collection of base data and the general methodology of projecting this out in to the future for each component. This report is not a technical handbook of how to run the growth model. It is a general descriptive document to give a general understanding of the processes used and issues dealt with in developing the growth model in the context of the Development Contributions Policy. In the future the Growth Model will have much broader use than just the Development Contributions Policy.

The Development Contributions Policy required a growth model that projects growth out to 30 years from the period of the LTCCP. 2041 was chosen as the end date of the model as this was consistent with the 30 year period and it also corresponded to the date of maximum projected household and population numbers in the City and Banks Peninsula using the medium projections from Statistics New Zealand (SNZ) (Figure 1).

Figure 1. Medium Household and Population Projections For Christchurch and Banks Peninsula 2001 - 2051



Source: Produced by Statistics New Zealand according to assumptions agreed to by Christchurch City Council.

Note that Statistics New Zealand does not release official population or household projections beyond 2026, however they have produced projections to 2051 for both Christchurch City and Banks Peninsula District on request for the Christchurch City Council. Also it is very difficult to anticipate what will happen beyond 20 years, as such these projections are based on a set of assumptions. Statistics New Zealand update their projections whenever new information is available (usually every 2-3 years). The growth model will be updated and refined as new information becomes available both from Statistics New Zealand and other sources such as Christchurch City Council.

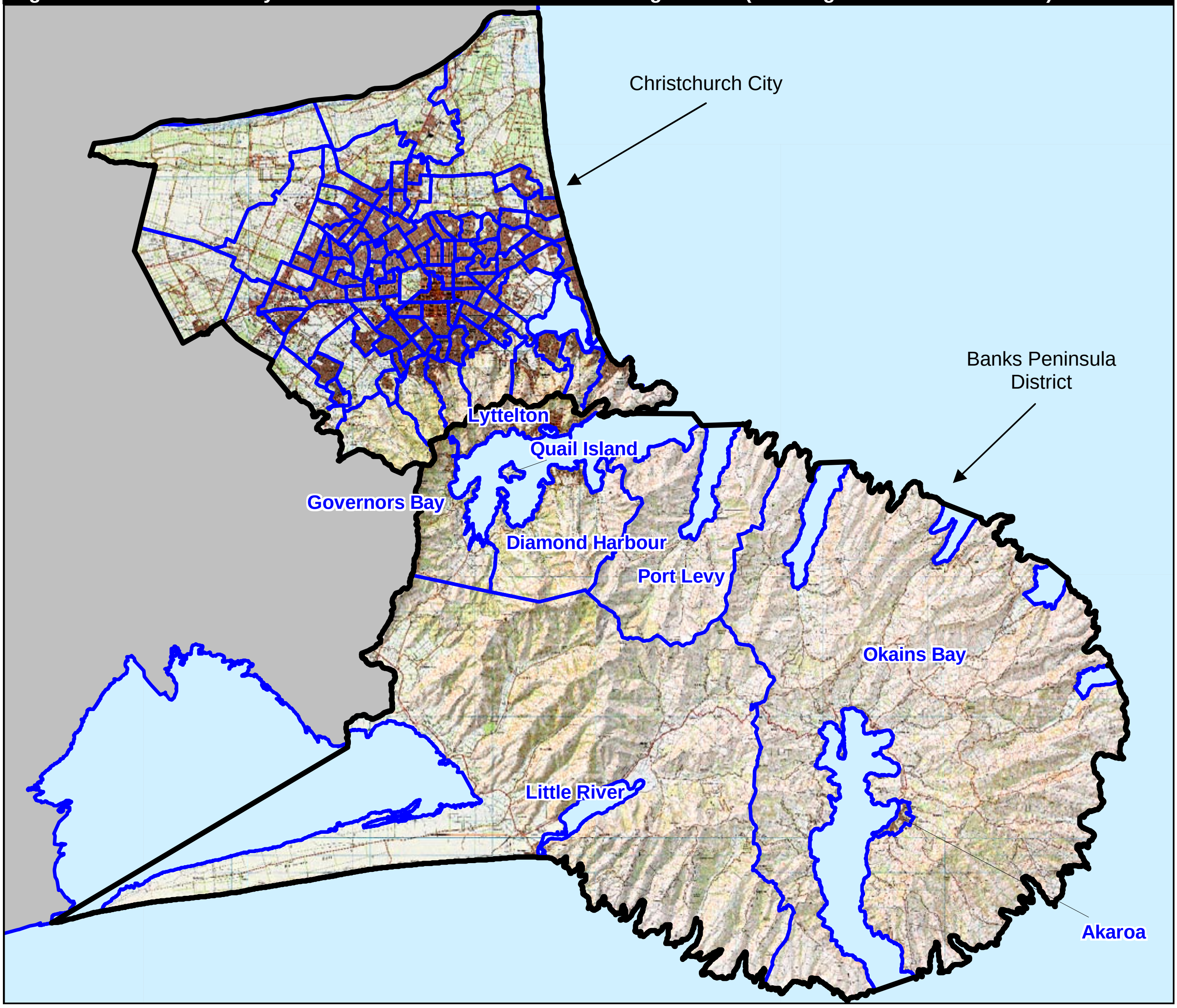
Table 1 below outlines the projections used in the growth model from external sources to calculate future growth in Christchurch City and Banks Peninsula District.

Due to the timing of amalgamation of Banks Peninsula District with Christchurch City, it has not been possible to treat both areas consistently in the modelling and in most cases Banks Peninsula District has been modelled separately to Christchurch City (Figure 1). As such this report has been structured so that base data collection and projections methods have been discussed for both Christchurch and Banks Peninsula when appropriate. This is a transitional issue that will be resolved as Banks Peninsula is integrated into Christchurch City and data is collected consistently across the new Christchurch City Council area. Note, in this

Table 1. Summary of Projections used in the Growth Model

Projection	Organisation	Base Year	Release Date	Comments
Christchurch and Banks Peninsula Household Projections 2001 - 2051	Statistics New Zealand	2001	October 2005	Produced by Statistics New Zealand according to assumptions agreed to by Christchurch City Council
Christchurch and Banks Peninsula Area Unit Household Projections 2001 - 2051	Statistics New Zealand	2001	October 2005	Produced by Statistics New Zealand according to assumptions agreed to by Christchurch City Council
Christchurch and Banks Peninsula Population Projections 2001 - 2051	Statistics New Zealand	2001	February 2005	Produced by Statistics New Zealand according to assumptions agreed to by Christchurch City Council
Canterbury Region Employment Projection 2001 - 2026	NZIER	2001		Produced for the Christchurch City Council. Employment figures from 2026 to 2041 have been extrapolated by Christchurch City Council

Figure 1. Christchurch City and Banks Peninsula District Pre Amalgamation (Showing Area Unit Boundaries) .



Source: Crown Copyright Land Information New Zealand, Statistics New Zealand.

report Christchurch and Christchurch City refers to the territorial area of the Christchurch City Council pre amalgamation with Banks Peninsula.

Household Component

The household component of the growth model was initially developed in the City Streets Unit as an input to the City Council's transport model. Although the transport model covers the Greater Christchurch Urban Development Strategy Area (see Appendix 1, Figure A1.1), it was also built with the flexibility to be extended to include all of Banks Peninsula District and the remaining parts of Waimakariri and Selwyn Districts. For transport modelling purposes it was only projected out to 2026, where the Development Contributions Policy needed to be projected out to 2041.

The households model uses Subnational Household Projections at territorial authority level produced by Statistics New Zealand. Christchurch City Council contracted Statistics New Zealand to extend the official projections beyond 2026 to 2051 for the Development Contributions Policy (Table 2). The projections are based on the 2001 census but were updated and released in October 2005.

Appendix 2 outlines the methodology SNZ used to calculate its projections.

Christchurch

The five yearly household projections produced by SNZ were distributed at a meshblock level using household data from the 2001

Census of Populations and Dwellings (Figure 3), and Vacant Residential Land information collected by the Council. Development is also distributed using factors such as topography (hills versus flat) and similar development constraints (e.g. medium density L2 to L4 areas are grouped in to a core area).

Projections were first split by the proportion of development occurring as infill and development on vacant green field and hill residential areas (Table 3). This has been determined from trends in residential building consent activity and vacant residential land information collected by the Monitoring and Research Team.

Infill capacity is determined as the difference between household density at 2001 and the maximum household density. Maximum household density for each meshblock is calculated as the 90th percentile of 2001 meshblock density for each zone, and determines the maximum number of households that could reasonably be expected to fit in a meshblock. The 90th percentile was used as it is unlikely that any meshblock would reach its maximum theoretical capacity (i.e. the area zoned in a meshblock divided by the minimum site size) and it relates future development to the higher order household densities that occur at present.

Capacity on areas of vacant green field land is based on the mean meshblock density for each zone from the 2001 census (refer Living Zone Density Report for details - http://www.ccc.govt.nz/Reports/TechnicalReports/2004/LivingZoneDensities/).

The proportions of the projections for infill, green field and vacant residential land on the hills are then distributed at meshblock level based on available capacity for each projection period. If any of the allocation exceeds the capacity of the area, these excesses can then be manually reallocated between sectors (core, suburban, rural) and infill, green field and hills. Figure 4 shows the 2041 projection at a meshblock level for Christchurch City.

This information is then aggregated up to census area unit level for it to be used for the Development Contributions Growth Model. The area units in the Four Avenues (Hagley Park, Avon Loop, Cathedral Square) were then adjusted to be consistent with the Statistics New Zealand Area Unit Projections[1] as the capacity based model did not adequately allow for growth in the Four Avenues as it was combined with the Living 2 and 3 areas in the core geographic area. In the future the model will need to be adjusted to better represent this area. The area units outside the Four Avenues were subsequently readjusted to allow for the increase in households within the Four Avenues.

Table 2. Summary of Household Projections 2001 to 2041

Year at 30 June		Christchurch City	Banks Peninsula	Total
2001		129,700	3,400	133,100
2006		138,800	3,600	142,400
2011		144,600	3,800	148,400
2016		150,900	4,000	154,900
2021		157,100	4,200	161,300
2026		162,800	4,400	167,200
2031		167,500	4,500	172,000
2036		170,500	4,600	175,100
2041		172,000	4,600	176,600
Change 2001 -2041	**Number**	42,300	1,200	43,500
	%	33	35	33

Source: Statistics New Zealand, Household Projections Produced for Christchurch City Council.

Table 3. Proportion of Household Development by form of Development

Development Type		Percentage of Development
Infill		45.1
Vacant Residential Land	Greenfield	45.5
	Hills	9.4

Source: CCC, Vacant Residential Land Register, Building Consent records.

Table 4. Living Zone Components used in Projections

Zone	Mean Meshblock Net Household Density	90th Percentile of Meshblock Net Household Density
Living 1	9.8	14.3
Living 2	13.3	19.7
Living 3	18.0	25.5
Living 4/5	22.4	45.0
Living Hills	5.8	14.3

Source: CCC, Living Zone Density Report 2004.

Banks Peninsula

Banks Peninsula household projections were calculated the same way as for Christchurch City, except that there was no distinction made between vacant and infill development. It is assumed all development occurs on vacant residential land. In addition to occupied dwellings a separate set of projections was developed for holiday homes in the District. Although they are not counted as occupied dwellings in the census, many holiday homes require similar levels of service to occupied dwellings, and they can easily become occupied on a full time basis without any change. In addition the growth in holiday homes is in the order of 27.5% of the occupied dwellings growth. In Akaroa growth in holiday homes between 2001 and 2041 is expected to be around 10 times greater than growth in occupied dwellings.

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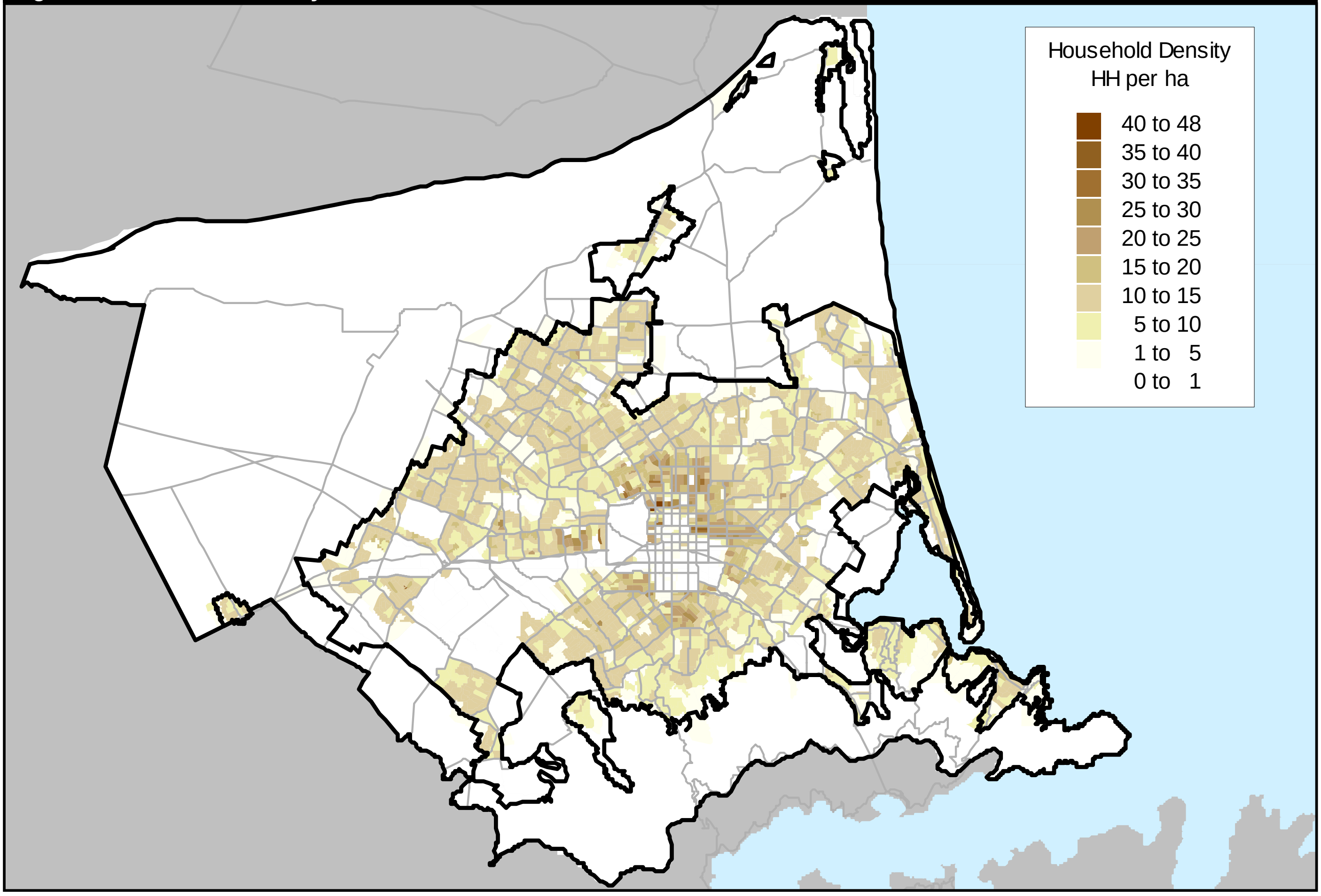
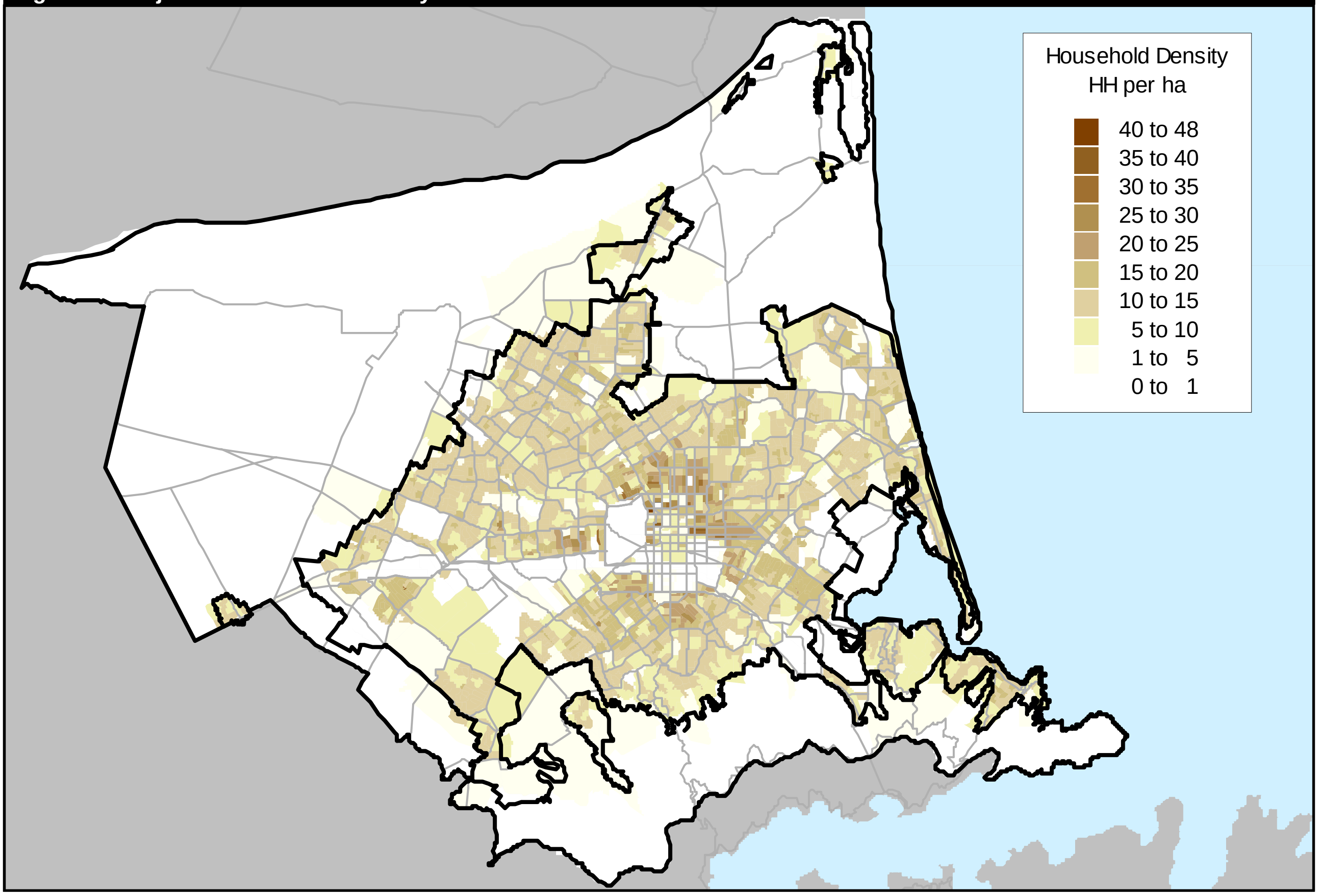
1. Statistics New Zealand, Area Unit Household Projections 2001 to 2051, base 2001, released October 2005. Produced by Statistics New Zealand according to assumptions agreed to by Christchurch City Council.

Figure 3. Household Density in Christchurch - 2001.



Source: Statistics New Zealand, 2001 Census of Population and Dwellings.

Figure 4. Projected Household Density in Christchurch - 2041.



Source: Christchurch City Council, Growth Model Household Component.

As a result the household projections for Banks Peninsula area units have two components - occupied dwellings and holiday homes.

Holiday home projections and vacant residential land for Banks Peninsula was obtained from the report: "Service Area: Population and Visitor Projections" prepared for Works and Services Unit Banks peninsula District Council, 31 March 2005 by ResponsePlanning Consultants Limited.

Summary of Household Assumptions

- Statistics New Zealand household projections are the best available estimate of future household growth at a territorial authority level. Their assumption of natural increase, migration and household occupancy are the best available.
- Sub City distribution of new households is determined on the basis that household growth is distributed according to the proportion of available capacity at a meshblock level for both infill and green field areas.
- When capacity is reached in a particular part of the City/District, any excess growth will be distributed evenly throughout the City/District - not to the surrounding area.
- Business as usual is assumed: That is no significant changes to zone boundaries or the nature of business zones in the future, as defined by the City Plan at June 2005.

Business Component

The business component of the growth model provides a projection of business floor area in the City from 2001 to 2041 in square metres of total floor area[2]. This required a base line of business floor area at a point in time and method(s) of projecting this out into the future. Note as with all projections, they are not predictions or forecasts, but represent the statistical outcome of various combinations of selected assumptions about future growth and dynamics of the City's business environment. These assumptions are based on the current trends and analysis available to the Council.

Base Data

Christchurch

The majority of the business floor area information used for the projections came from the Councils District Valuation Roll database (referred to as the Valuation Hub) for the 2006 rating year. A snapshot of the Valuation Hub for properties in business zones was taken at October 2005. The Valuation Hub is continually being updated as buildings change, triggered for example through the building consent process.

The total floor area of each rate account is stored in the Valuation Hub. This data is stored for each rate account and then can be linked through Council's GIS Cadastral layer to different geographically defined parts of the City, e.g. zones. However, at the beginning of November 2005, 799 of the 9,918 land parcels in the Business and Central City Zones[3] did not link between the valuation hub and the current land parcels (cadastre). In addition to the parcels that didn't link to the Valuation Hub, there were a number of current records that didn't have any total floor area recorded in the Valuation Hub. Due to the restricted time frame to carry out this analysis and the limited resources in the Data Intelligence Unit due to staff being seconded to work through the data issues arising out of the amalgamation with Banks Peninsula District. It was decided to estimate the floor area for the missing records using the Council's Lidar[4] dataset.

To estimate the floor areas of the properties with missing floor area, least squares linear regression equations were calculated from the records which had a total floor area record in the Valuation Hub. The building volume was calculated from the building footprint and building elevation data from the Lidar dataset. Regression equations were generated for each valuation mass appraisal "Highest and Best Use" category for each zone. The Highest and Best Use category describes the activity that a building or property is best used for. This resulted in 110 separate regression equations. These were then aggregated to a single conversion factor for each zone by weighting the values from each of these regression equations by the floor area of each Highest

2. Total Floor Area is defined in the rating valuation rules and records the total floor area of the principal structures, but excludes the floor areas covered by eaves, open porticos, open verandas etc. This is consistent with the term Gross Floor Area used in the Christchurch City Plan, expect that it includes all buildings rather than the principal structures. See rating Valuations Rules for definition of principal structures.

3. Zones Included in the analysis were: Business 1 (Local Centre); Business 1P (Local Centre Parking); Business 2 (District Centre); Business 2P (District Centre Parking); Business 3 (Inner City Industrial); Business 3B (Inner City Industrial buffer); Business 4 (Suburban industrial); Business 4P (Suburban Industrial—Produce Park); Business 4T (Suburban Industrial-Technology Park); Business 5 (General industrial); Business 6 (Rural Industrial); Central City; Central City Edge (Variation 83).

4. Lidar—This is a airborne based active remote sensing system that transmits a pulse of laser light beneath an aircraft which is reflected from the ground surface. This provides a highly accurate digital elevation model (DEM) which includes building forms. It was these building forms that was used in this analysis. The council's current Lidar information was collected from the 6 to 9th July 2003.

Table 5. Summary of Total Floor Area Projections for Each Zone Groups (Square Metres)									
Zone Groups	2001	2006	2011	2016	2021	2026	2031	2036	2041
B1	255,950	264,050	265,650	268,550	271,050	273,300	275,150	276,400	276,900
B2	386,050	513,450	538,800	584,350	624,150	660,300	689,650	709,000	716,900
B3	1,236,350	1,298,600	1,315,200	1,320,950	1,320,950	1,325,950	1,329,050	1,330,500	1,330,750
B4	1,248,550	1,579,550	1,674,500	1,707,350	1,709,650	1,730,750	1,743,750	1,750,000	1,750,900
B5	1,589,750	1,925,250	2,018,250	2,050,400	2,050,400	2,070,250	2,082,450	2,088,300	2,089,100
B6	49,950	76,900	84,650	87,300	87,300	89,300	90,550	91,150	91,250
BRP	99,800	110,750	116,850	127,850	137,450	146,150	153,250	157,950	161,550
CC & CCE	1,536,250	1,554,450	1,639,800	1,725,150	1,810,450	1,895,800	1,981,150	2,064,050	2,146,900
Banks Peninsula	115,913	116,250	124,450	132,600	140,800	148,950	157,100	165,250	173,400

Source: Christchurch City Council, Business Growth Model.

and Best Use category in each zone. Activities were excluded from this analysis if they had less than 5 per cent of the zones total floor area. The assumption being that any new activity is more likely to reflect the major activities in a zone than the minor ones and the fact that some of the minor activities, e.g. residential, would be unlikely to occur under current zoning provisions. This also had the effect of removing vacant properties from the analysis. As a result the number of regression equations used to calculate the conversion factors for each zone was reduced to 36. Appendix 3, Figure A3.1, shows graphs of the R squared values and proportion of the total floor area used in each zone by highest and best use activity. The majority of the R squared values generally explain over 80 percent of the variation around the least squares regression line between building volume and the total floor area of a building.

In the future there should be no need to estimate missing values using the Lidar data, as systems are being put in place to ensure that all the floor area information required can be extracted from the Valuation Hub.

Table 5 and Figure 5 show a table of the projections for each group of zones, and a map of the base floor area for June 2005 in Christchurch respectively.

Banks Peninsula

Neither Banks Peninsula District Council or Christchurch City Council had collected floor area for commercial buildings in the Banks Peninsula District. Building footprints were collected from the Banks Peninsula digital orthophotos which were flown in May and June 2000. These were then field checked to collect the number of stories to calculate the total floor area. Total floor area was collected for all commercial buildings in Banks Peninsula—however projections were only constructed for those areas zoned for commercial or industrial[5] activities. The assumption being that growth in commercial or industrial activities will occur in those areas zoned for these activities.

Projection Methodology

Christchurch

The rates of growth in the business floor space in the City were calculated for each individual business zone from the Council's commercial building consent records which are routinely collected and analysed. This information dates back to July 1991 for most of the zones or groups of like zones (Appendix 3, Table A3.1 for summary of this information). The exceptions are for the Central City where the time series started in 1966 and newly created zones such as Business Retail Parks (BRP) which have data only going back to the creation of the zone in August 2004.

Historic floor area growth data for consents was analysed to identify relationships with key drivers that are able to be projected into the future. These included population change, economic activity and employment. A summary of the methods used for each zone is summarised in Appendix 3, Figure 3.4 to 3.8. Cumulative growth rates were used in the analysis to take into account lag effect caused by growth pressure and development often occurring in different or over several annual periods.

Generally business growth for each zone fell into two main methods. Those such as the Central City which for over the past 40 years had a consistent average annual growth in the order of 16,500 new square meters per year; And the other zones where floor area growth related to a key driver such as either the City's population growth, for example Business 2 zones; or regional economic activity, as measured with the National Bank Regional Economic Activity Index. In the cases that related to economic activity, Regional Employment Projections were used to project out the floor area growth as the National Bank Economic Activity Index does not provide projections of economic activity, and the NZIER Canterbury employment projections showed a very strong correlation with the National Bank Regional Economic Index (see Appendix 3, Figure 3.3).

These relationships make sense as the Business 1 and 2 zones are composed of primarily retail and service activities, which are

5. Banks Peninsula commercial and industrial zones are: Lyttelton Port, Town Centre, and Industrial.

driven by residential demand in Christchurch and the rural area surrounding the City. Therefore over time as the number of people increases the amount of floor area has historically increased as a result. There is no reason to assume this pattern will change unless the issue of capacity restricts growth in particular areas. It is also reasonable to relate industrial development to regional economic activity, as essentially Christchurch's industrial business activity is driven by economic activity within the City and in the rural areas in Canterbury, for example if the rural economy is strong, City businesses will respond to this demand.

Once the total amount of floor area was calculated for each zone it was distributed at a sub city level as either infill development or development on vacant industrial land. Historic building consent information was used to determine the proportion of future development that would occur as either infill or on vacant land. This proportion is shown in Appendix 3, Table A3.2. This information is modelled at a Statistics New Zealand meshblock and zone level—so if for example a meshblock is split by two zones these two areas are modelled separately.

The City wide projections were then distributed at the meshblock level based on the available capacity. Available capacity is the difference between the current floor area in each meshblock zone and the maximum floor area in each meshblock zone. Maximum capacity is calculated as the 90th percentile of current floor area density (the ratio of floor area to the site area in square metres for all the sites in each zone) for each meshblock zone. Areas with the greatest amount of remaining capacity will get proportionally more growth. This is the simplest method of distribution, the alternative would be to try and predict areas of preferred growth which would require knowledge of current and future market preferences. In the future it is intended to try and build this level of sophistication into the model if it adds value and can be logically predicted. But under the time constraints of developing a model for the development contributions policy this was not attempted in the first iteration of the business component.

When a zone reached capacity, for example the B4P zone. The excess growth was transferred to a similar zone that could allow similar activities such as B4 in this example. Figure 6 shows the distribution of projected business floor area at the end of the projection period, 2041 for each meshblock.

This information was then aggregated up for each zone grouping to census area units for use in the development contributions growth model. It was then rounded to the nearest ten square metres.

Banks Peninsula

Business projections for the area currently covered by Banks Peninsula were created in a similar way. Commercial building consent information however was obtained from the Statistics New Zealand's Building Consent data set (using INFOS), as Banks Peninsula District Council has not compiled this information. Unfortunately this was only available for the whole of the District Council area and was not split between zones or townships. As such any projected growth was allocated using the existing business floor area in each area unit. The rate of growth was relatively small compared with the zoned area, so exceeding capacity was not considered an issue. In the future Banks Peninsula sub district distribution of growth will be explored further and this area will be included with the Christchurch area for modelling.

Summary of Business Assumptions:

- Future growth will follow trends and relationships similar to historical patterns.
- Business as usual is assumed: That is no significant changes to zone boundaries or the nature of business zones in the future, as defined by the City Plan at June 2005.
- The rate of development activity within a zone is consistent throughout the City and Banks Peninsula and future development rates relate to the proportion of available capacity within each zone.

Impervious Component

The impervious component of the growth model provides an estimate of the area of impervious surfaces in the urbanised areas of Christchurch City and Banks Peninsula District. Impervious surfaces are important in the context of surface water and stormwater runoff, as the more impervious surfaces in a catchment the greater the quantity and intensity of runoff. In addition the area of impervious surfaces in a catchment is a good indicator of pressures on the quality of an urban waterway.

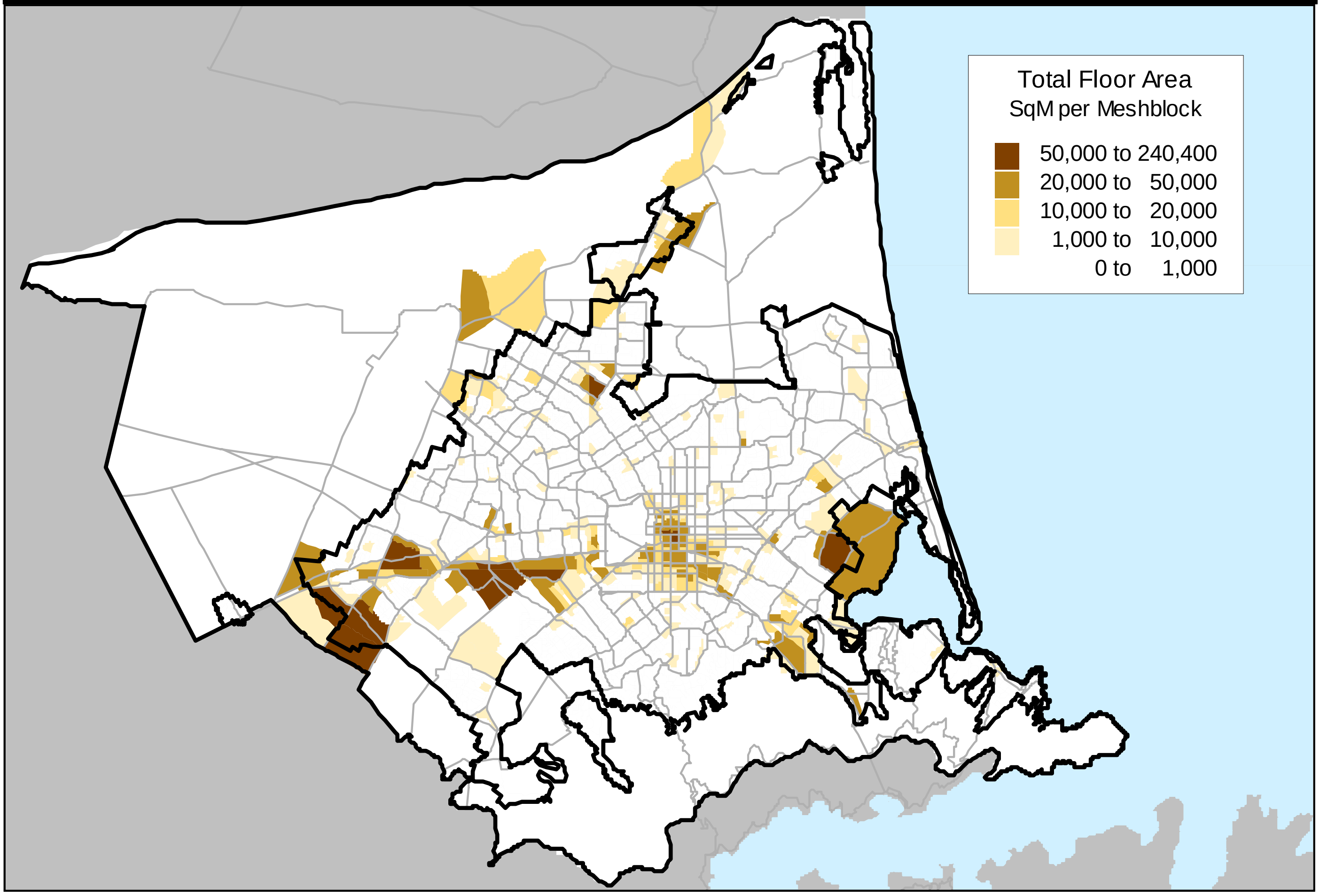
A base data set of impervious surfaces was required for this project. At the start of the project the Council did not have information on impervious surfaces available for the whole of the City and Banks Peninsula District. So this needed to be collected before the projections could be modelled.

Base data

Christchurch

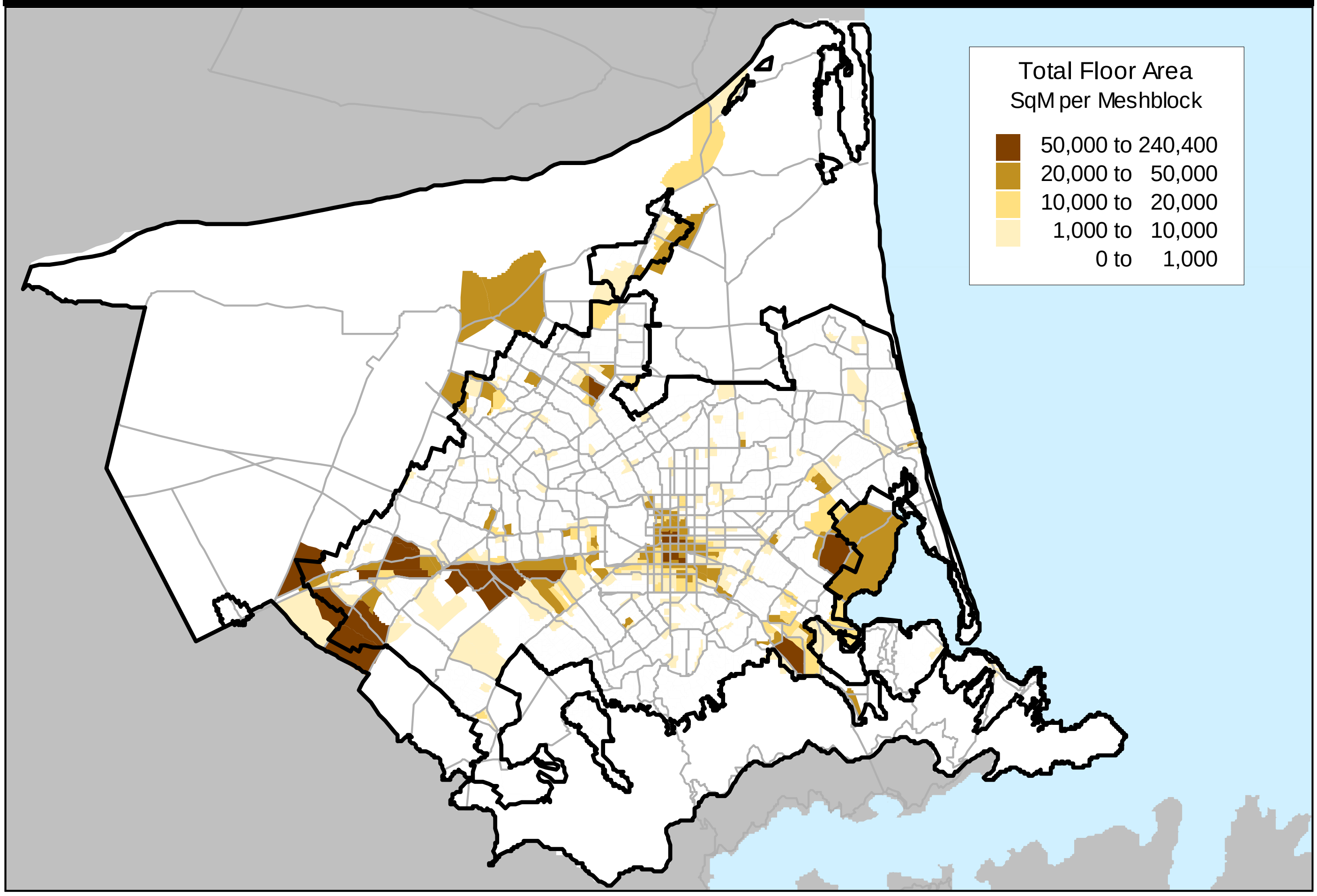
Christchurch City Council has been working with Landcare Research (and partially funded by FoRST) to estimate the amount of impervious surfaces in the City using satellite imagery. This work provided a base line of impervious surfaces that was used for

Figure 5. Map of Business Floor Area in the City at June 2005.



Source: Christchurch City Council, District Valuation Roll, Christchurch City Council LIDAR data.

Figure 6. Map of Business Floor Area in the City at 2041.



Source: Christchurch City Council, Growth Model Business Component.

the Development Contributions Growth Model. Figure 7 shows a map of the percentage impervious surfaces in the City. This was obtained from a Landsat 7 image collected in February 2000.

The Christchurch impervious base layer is a GIS raster file with 25 metre grid cells and a value of the percentage impervious for each grid cell. Therefore a grid cell with a value of 60 percent would have 15 square metres of impervious surfaces. For additional information on the accuracy and creation of this GIS layer refer to the Landcare Report: "Accuracy Assessment of Christchurch City Impervious Surface Maps Derived from Satellite Imagery" by Heather North and Stella Bellis published April 2005, LC0405/088).

This raster file was then aggregated to a vector layer providing the average percent impervious for each meshblock and zone. Usually most meshblocks will only have one zoned area, but many will have more than one zone within it (5,585 meshblock zones compared with 2,710 meshblocks in the City). This enabled the impervious surfaces calculations to be consistent with both the household projections and business projections which were used to determine the changes in imperviousness. Also because each zone has potentially distinctive development patterns it was appropriate to build the model at this level.

In addition to the impervious information being aggregated at meshblock zones, a subset of this information was created for each meshblock zone which contained only the impervious surfaces information for the areas of road and areas associated with roads such as footpaths. The reason for separating this out was to enable it to be separated from the analysis as it is assumed to remain unchanged over the time of the projections, and if it did change it would be difficult to anticipate what form this change would be.

This method assumes that trees overhanging impervious areas are treated the same as grass and other vegetative surfaces, From a hydrological perspective they will behave differently to impervious surfaces in that they will intercept rainfall, which will either evaporate or trickle and drip to the ground. Unfortunately without any information about what is underneath trees and also what type of tree there is, it is extremely difficult to treat these areas any differently. Also when you include the fact that the time of the year and the intensity and amount of rainfall also determine the runoff behaviour of trees. This would be a complex task to do anything differently, and would be beyond the scope of what is required for the development contributions.

Banks Peninsula
The base information for the Banks Peninsula District was collected from the digital orthophotos covering the district. Data was only collected for the urbanised parts of the District as it was assumed that rural area would not change significantly to effect storm water infrastructure and in most cases have natural watercourses for runoff. The average proportion of impervious surface was calculated by randomly sampling properties (or all properties in small zones) in the different zones and aggregating this up to give an average figure for the whole zone in each township.

In the future it is intended that the satellite imagery will be extended to include the rest of the Peninsula to provide a single source of impervious data for the whole of the new Christchurch City Council area post amalgamation.

Projection Methodology

The methodology for Christchurch and Banks Peninsula area projections are the same although the collection of base data was different.

Impervious surfaces were projected out for residential and business zones. It was assumed that other zones such as open space and conservation would not change significantly over time. For these areas with assumed no growth the current areas of impervious surface were kept the same for future projection periods. This may not necessarily be the case but without additional survey work and time series analysis of impervious surfaces the relative size of any of this change cannot be determined. In addition any changes in residential and business areas are likely to have significantly more impact on City's impervious surfaces than changes in these zones. Zones assumed to stay constant over time were:

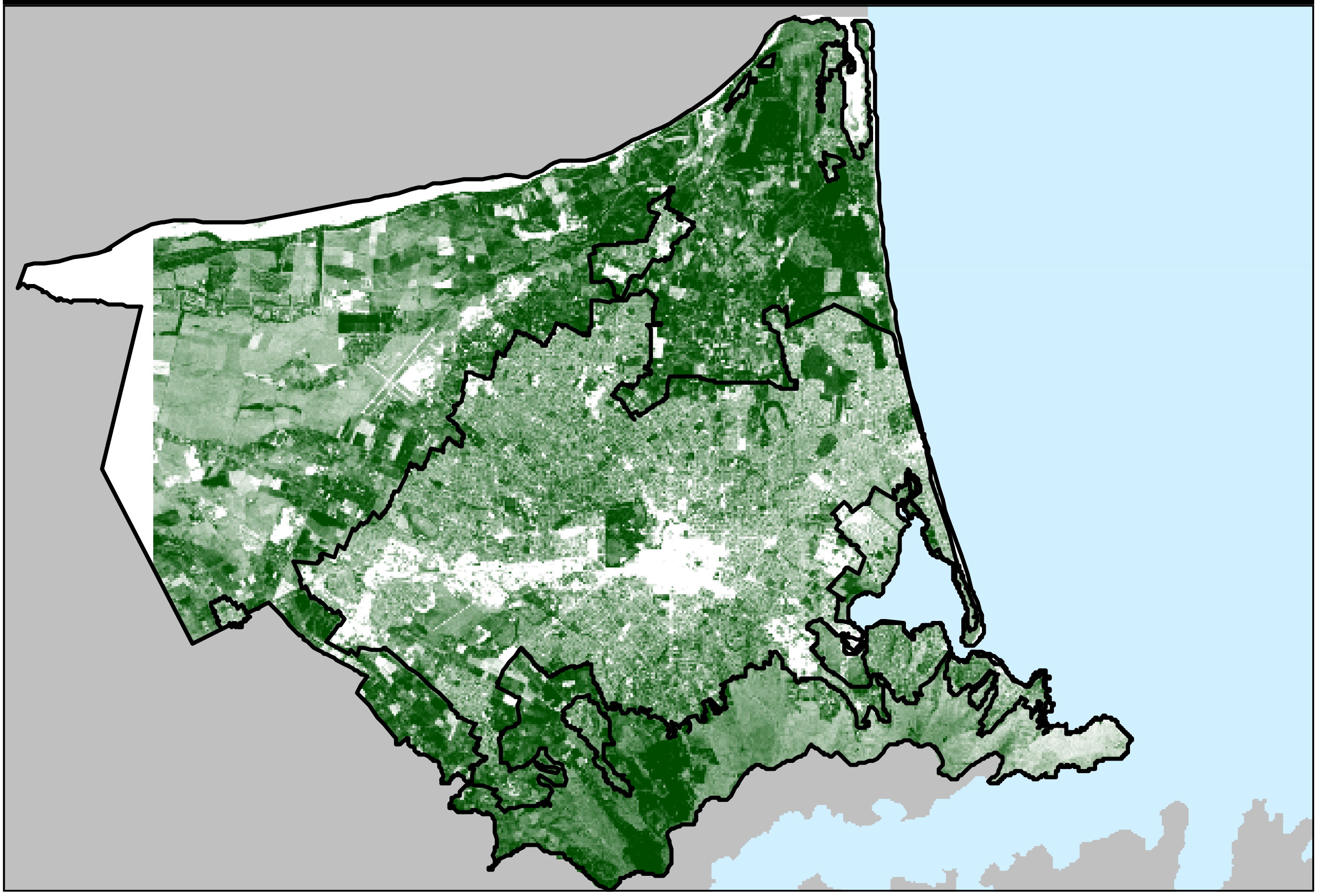
- Open space
- Cultural
- Conservation
- Rural
- Special Purpose (except Airport, Awatea and Wigram).

Residential and Business zones were calculated separately, but effectively used the same general methodology. Each meshblock zone area is divided into the area covering land parcels and areas of roading and associated non parcel features, such as footpaths and grass verges. The non parcel features are assumed to remain constant over time, so any change due to growth is applied to the area covered by land parcels only.

Initially relationships between current impervious surfaces and other variables such as number of dwellings / households, socio economic status (NZ deprivation index) , building footprint area, geographic location were examined both in combination and separately to attempt to produce a regression based model to predict future impervious surfaces from the household and business projections. Unfortunately the results showed that there were no relationship strong enough to confidently use this methodology for projecting out impervious surfaces.

These results show that even within similar parts of the City there is a wide variation in the nature of dwellings and commercial buildings, and combined with the additional variation in the site size, personal preferences in landscaping and additional buildings means that the urban fabric of the City is incredibly diverse.

Figure 7. Proportion Impervious Surfaces in Christchurch (Green 100% - White 0% impervious, Black areas Excluded from the Analysis



Source: Landcare Research, NASA Landsat 7 Satellite Imagery.

Subsequently, it was decided to use a methodology based on proportionally increasing the amount of impervious surfaces based on the proportional growth in either households or commercial building floor area for each meshblock zone area. This method is based on the assumption that the nature of impervious surfaces of any additional development within a meshblock zone should be consistent with the current nature of existing development. That is in suburban residential areas where there is additional infill, it will generally be in keeping with the existing proportions of impervious surfaces. Note this may not be the case in areas that are undergoing significant change. This would need to be investigated in the future when time series of impervious surfaces in the City is available.

Projected impervious surfaces are increased to a maximum level of imperviousness for each zone. This is calculated as the 90th percentile of meshblock mean percent impervious for each zone. This allows for the fact that in most zones when densities increase above a particular level there will still be a requirement for some vegetative surfaces especially in residential areas, also at medium to higher densities increased residential density results in vertical development - which does not change the impervious surfaces. Some commercial zones such as the Central City are likely to be or approach 100 percent impervious, and any additional development will not have any effect.

In meshblocks where there was no households in 2001, that is areas of green field development, the impervious surfaces of new areas will be different to what is already there. To estimate the amount of impervious surface due to the projected number of households in green field areas the proportion of impervious surfaces and mean site size on green field areas that had been developed on vacant residential land since 1998 was assessed (1998 was the first year GIS based vacant land information was collected). This was then applied to green field areas which were projected to have future development.

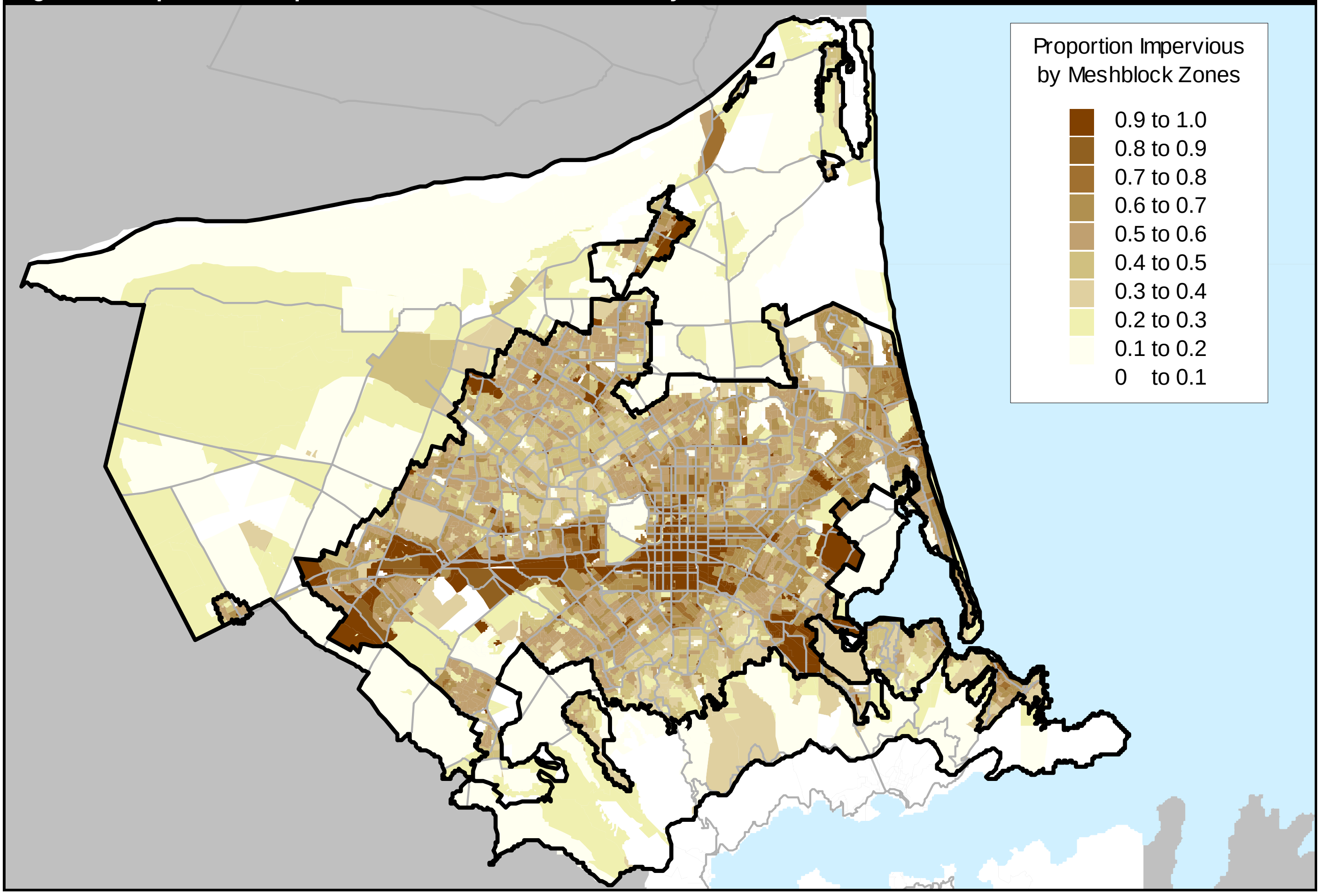
Growth in impervious surfaces as a result of business growth is treated essentially the same way, except instead of proportioning out growth using households, business floor area is used instead.

This information is aggregated together at a meshblock and zone level and then to a census area unit level and then rounded to the nearest 10 metres for the growth model input. The data is rounded because otherwise it would give the impression of a level of accuracy that is not achievable.

Summary of Impervious Assumptions:

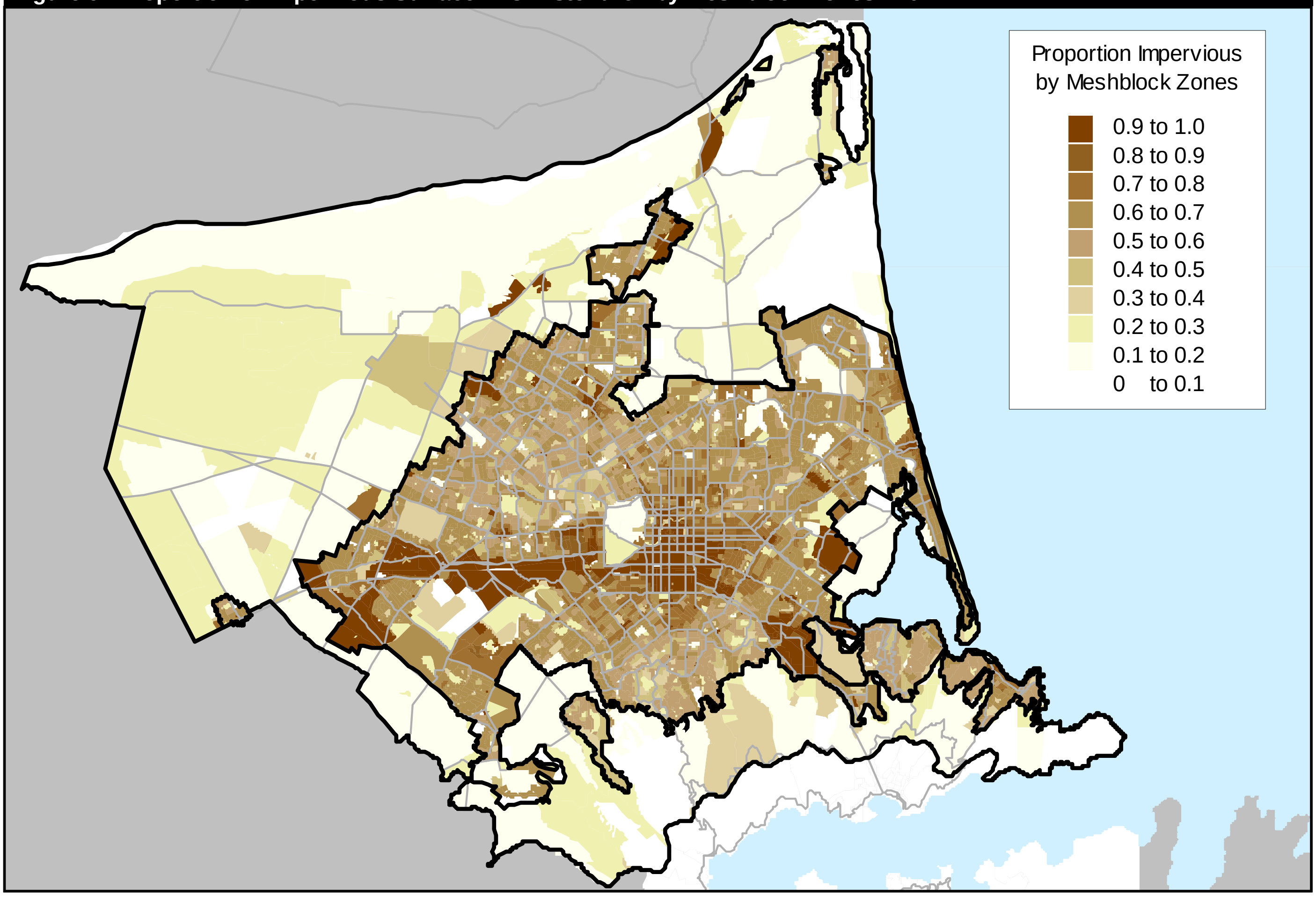
- It is assumed that future development within each meshblock zone area will be consistent with existing development at the local scale.
- Impervious surfaces in green field developments will be similar to those in recent development in green field areas.
- Growth in impervious surfaces will generally not exceed the 90th percentile of current levels of impervious surfaces for each zone.

Figure 8. Proportion of Impervious Surface in Christchurch by Meshblock Zones - 2001.



Source: Christchurch City Council, Growth Model Impervious Component .

Figure 9. Proportion of Impervious Surface in Christchurch by Meshblock Zones - 2041.



Source: Christchurch City Council, Growth Model Impervious Component .

Implications of Under or Over Estimating Growth

This section summarises the implications of over or under estimating growth. Figure 10 below shows a simplified example of household growth over a 25 year period. At T1 (2006) additional capacity (C2 - C1) was added to increase capacity to account for the demand created by the amount of household growth anticipated to occur between T1 and T2.

In this example the anticipated growth is considered to be linear, which we know is unlikely to occur as growth tends to go through cycles of high and low periods. However this is not that important as infrastructure tends to be put in place in anticipation of the total amount of growth over a specific time period rather than individual periods of high or low growth. In the example in Figure 10, over the 25 year period it is estimated that the number of households will increase from 120,000 to 160,000, an increase of 40,000. This is an average growth rate of 1600 households per year. Infrastructure capacity required to service this growth is an additional 60,000 units. This means that for each additional household the infrastructure capacity has to increase by 1.5 units (60,000 divided by 40,000).

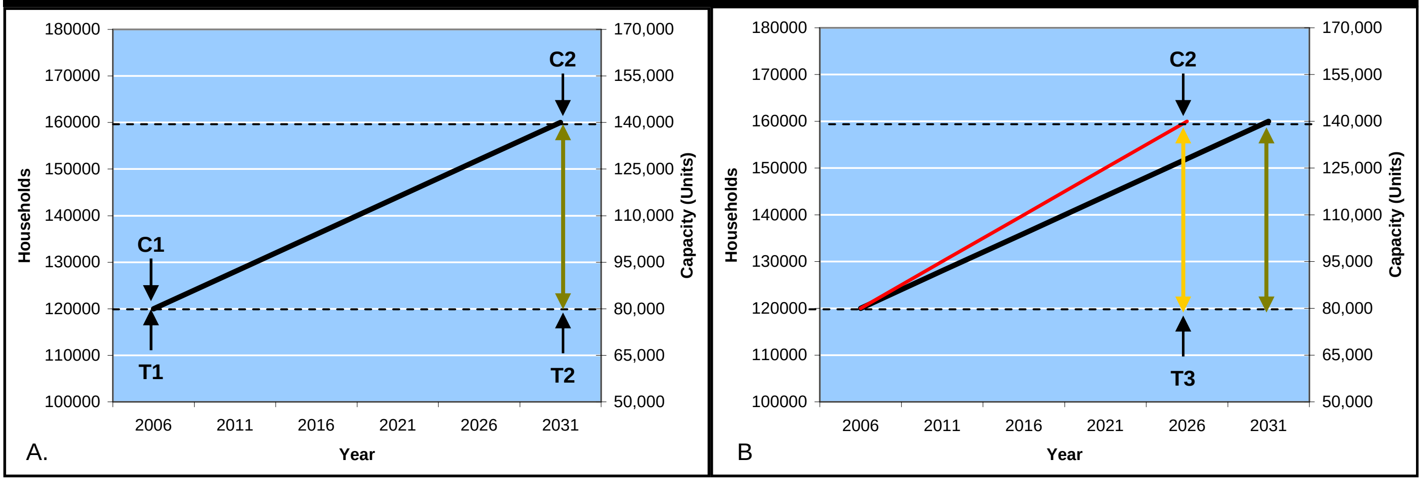
If household growth was higher or lower than projected the period (T1 to T2), the time taken to reach the estimated number of households either is shorter or longer than planned, respectively. Figure 10B shows the example of growth being at a higher rate than expected. It only takes 20 years for the number of households to increase by 40,000. The average annual growth rate increased from 1600 to 2000 households per year. However, these 40,000 households still only require an increase in infrastructure capacity of 60,000 units.

In summary, changes in the projected amount of growth influences the timing of additional infrastructure investment to meet the additional household growth or conversely the delay of investment if growth is lower than anticipated. However, the under or over estimation of growth has implications in the funding model and the subsequent development contribution charges through the funding rules. For example if growth is under assessed and demand arrives earlier than anticipated then early assessments of the DC charge will have a higher interest component and therefore may result in a higher charge than latter arrivals, conversely if growth is over assessed it is likely that the funding effects will cause under recovery from early arrivals.

Also if the design life is longer than the funding period (30 years) then the charges are determined from the arrivals in the first 30 years of the life of the project. It is interesting to note that increasing the funding period to an extended design capacity life (greater than 30 years) is likely to increase the charge to all arrivals as the interest component starts to dominate. Refer to the Methodology for Determining Development Contribution Charges by SPM Consultants on the website for more detail on the DC funding model.

Although it is impossible to know exactly what growth will be in the future, by updating the growth model when new information comes available will minimise the impacts of over or underestimating growth.

Figure 10. Example of Under or Over Estimation of Growth

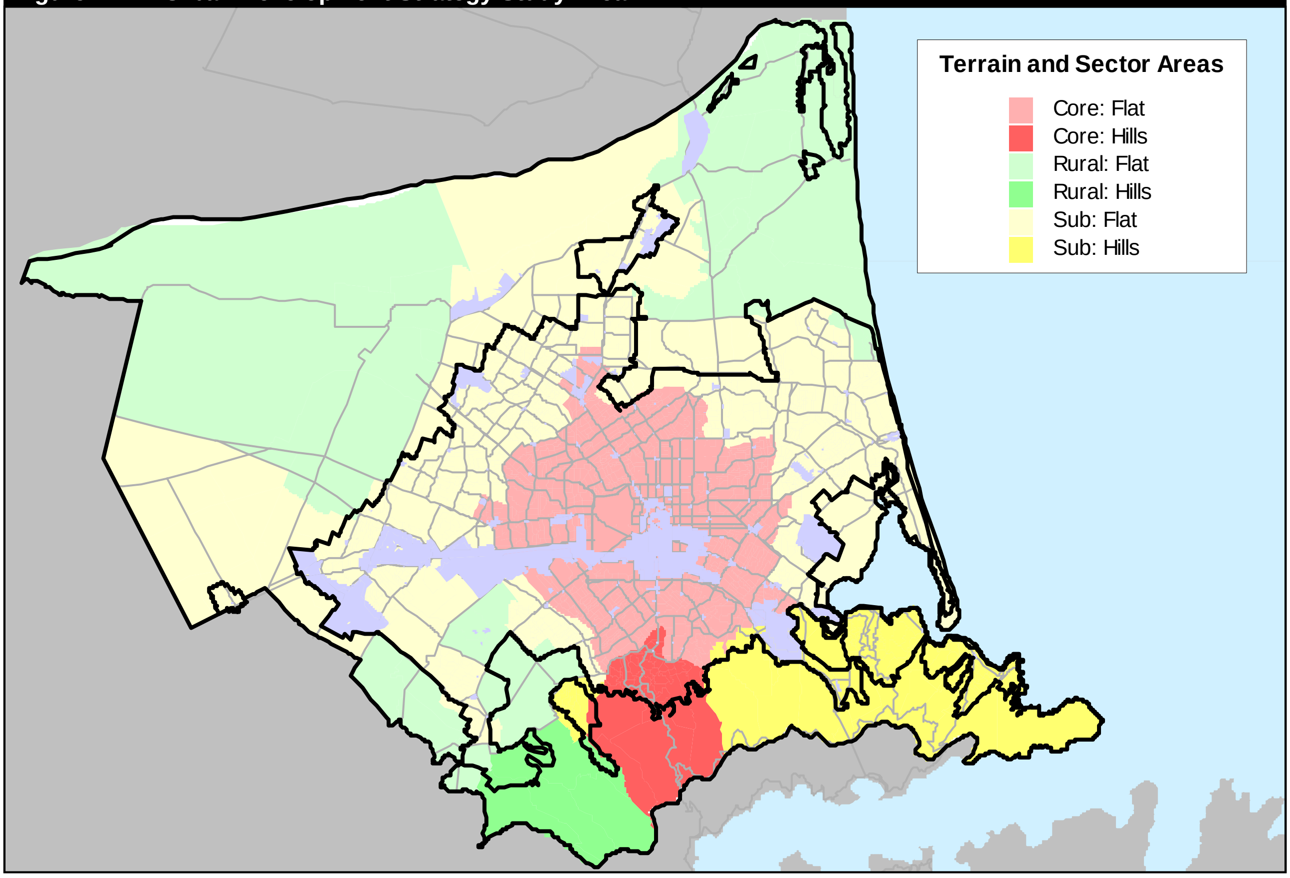


Appendix 1. Household Component Supporting Information

Figure A1.1. Urban Development Strategy Study Area

Source: Greater Christchurch Urban Development Strategy.

Figure A1.2. Urban Development Strategy Study Area



Source: Christchurch City Council, Growth Model Households Component.

Appendix 2. Summary of SNZ Projection Methodology

(Source: http://www.stats.govt.nz/additional-information/projections-overview.htm)

Family and Household Projections

Information on the official subnational family and household projections produced by Statistics New Zealand can be found on the SNZ website are the following address: http://www.stats.govt.nz/additional-information/projections-overview.htm#subnatfam.

The subnational family and household projections were derived from the subnational population projections by multiplying the projected population by assumed living arrangement type rates for each age-sex group. Three projection series (low, medium and high) have been produced, using different fertility, mortality and migration assumptions. One set of living arrangement type rates has been used for all three series.

All 16 regional council areas and 63 of 74 territorial authorities are projected to have more households in 2021 than in 2001. In comparison, only 11 regional council areas and 41 territorial authorities are projected to increase in population over this period. For all regional council areas and territorial authorities, the growth rate of the number of households is projected to be higher than that of the population due to a decline in average household size. This reflects an increasing proportion of one-person households and a decrease in the average size of family households. These trends are driven mainly by the general ageing of the population. Average family size is projected to decline largely because of an increase in the proportion of 'couple without children' families (which contain two people) and a decrease in the proportion of 'two-parent' families (which contain about four people, on average).

SNZ extended the family and household projections out to 2051 as a customised job for Christchurch City Council. Living arrangement type rates (which are the propensity for someone to live in a certain living arrangement type, such as a person in a one-person household, by age and sex) were kept constant after 2021, and these were applied to population projections for each area out to 2051. From the resulting population by living arrangement type, families by family type and households by household type were calculated out to 2051.

Population Projections

The latest projections of the population living in subnational areas was released in February 2005 and covers the 16 regional council and 74 territorial authority areas of New Zealand. Three alternative projection series (designated low, medium and high) were produced for each area incorporating different fertility, mortality and migration assumptions reflecting each area's unique socio-demographic characteristics. The following results are based on the medium series.

Of New Zealand's 74 territorial authorities, 39 are projected to have more people in 2026 than in 2001. However population growth will generally slow over the projection period. While 48 territorial authorities are projected in increase in population between 2001 and 2006, this will reduce to 33 between 2021 and 2026.

An important factor in the slowing of population growth is the narrowing gap between births and deaths. Nationally, natural increase (births minus deaths) is projected to decrease from 141,000 in the five years ended June 2006 to 86,000 during 2022–2026. Just 13 territorial authorities are projected to have more births in 2022-2026 than in 2002-2006. In contrast, the number of deaths is expected to increase in almost all territorial authorities, because of the increasing number of people born after World War II reaching the older ages. While three territorial authorities (Horowhenua, Waimate and Waitaki districts) experienced more deaths than births in the five years ended December 2004, this number is expected to increase to 24 by 2022-2026.

The subnational projections for Christchurch and Banks Peninsula were extended out to 2051 by SNZ by holding the fertility, mortality and migration assumptions constant. This may or may not give plausible results by 2051.

Area Unit Population Projections

Area unit population projections provide an indication of likely changes in the future size and age-sex structure of the population. .

Area units are roughly the size of suburbs, but the 1,860 area units cover all of New Zealand. The median size of area units is 1,900 people, while three-quarters of area units have a population between 100 and 4,000.

The latest 2001-base projections of the population usually living in each area unit cover the period to 2026 at five-year intervals. These projections were completed during February-June 2005 and supersede the 2001-base series completed in April 2003. The area unit population projections are updated every 2–3 years.

What is the base population?

These projections have as a base the estimated resident population of each area unit at 30 June 2001. This population was based on the census usually resident population count for each area unit and adjusted for:

- net census undercount
- residents temporarily overseas on census night
- births, deaths and net migration between census night (6 March 2001) and 30 June 2001

- reconciliation with demographic estimates at ages 0–9 years.

The estimated resident population, and projections thereof, are not directly comparable with census counts. Census counts give a snapshot of the population and are not adjusted for net census undercount or residents who are temporarily overseas.

Three alternative series (designated low, medium and high) have been produced for each area unit using different fertility, mortality and migration assumptions. At the time of production, the medium series is considered the most suitable for assessing future population change and is consistent with series 5 of the 2004-base National Population Projections released on 16 December 2004 and the medium series of the 2001-base Subnational Population Projections (regions, cities and districts) released on 28 February 2005.

The low and high series allow users to assess the impact on population size and structure resulting from more conservative and optimistic demographic scenarios, respectively. These are independent of any series of the national or subnational population projections as they represent plausible alternative scenarios for each area unit rather than at any aggregate level. The low projection series uses low fertility, high mortality and low net migration for each area. The high projection series uses high fertility, low mortality and high net migration for each area.

Nature of projections
Demographic projections are designed to meet both short-term and long-term planning needs, but are not designed to be exact forecasts or to project specific annual variation. The area unit population projections are based on assumptions made about future fertility, mortality and migration patterns of the population. Although the assumptions are carefully formulated to represent future trends, they are subject to uncertainty. Therefore, the projections should be used as guidelines and an indication of the overall trend, rather than as exact forecasts.

While the projections take account of land planning and other decisions by governments known at the time the projections were made, Statistics New Zealand does not always have access to the policies or decisions of local and central government and businesses that assist in accurately forecasting small area populations. The projections do not take into account non-demographic factors (eg war, catastrophes, major government and business decisions, economic factors) which may affect future demographic behaviour. The unpredictability of migration trends, especially in the short-term, can have a significant effect on projection results.

It is important to recognise that the projections simply reflect the assumptions made about future fertility, mortality and migration trends. While the assumptions are formulated on the basis of an objective assessment of demographic trends over the past decade and their likely future dynamics, there can be no certainty that they will be realised.

Method and assumptions
The cohort component method has been used to derive the population projections. In this method the base population is projected forward by calculating the effect of deaths and migration within each age-sex group according to specified mortality and migration assumptions. New birth cohorts are generated by applying specified fertility assumptions to the female population of childbearing age.

Projection assumptions are formulated after analysis of short- and long-term historical trends, government policy, information provided by local planners (eg housing subdivisions, zoning changes, commencement/expansion/closure of industries) and other relevant information which may affect population change in each area. The projections incorporate the latest demographic information available at the time of production, including subnational population estimates at 30 June 2004, and birth and death registrations to December 2004.

The assumed fertility and mortality rates are based on the registered births and deaths, respectively, for each area to 2004. The assumed rates are also consistent with the assumed rates for higher geographic levels (ie medium fertility and mortality variants for each territorial authority and New Zealand).

Migration at the subnational level has both external migration and internal migration components, although these separate components are difficult to quantify because of insufficient data. The assumed future net migration for each area is based on a consideration of observed net migration during each five-year period from 1981 to 2001, the capacity of the area for further growth (for areas with net inflow), whether historical outflows can be sustained (for areas with net outflow), the desirability of the area to new migrants, and information available from and about local authority areas relating to current and future developments which may affect population change.

Area Unit Household Projections

The area unit household projections are derived from area unit population projections, but then constrained to the projected change in households at the territorial authority (city or district) level. Unlike area unit population projections, SNZ does not check the plausibility of household projections for each area unit.

There are three steps in deriving area unit household estimates/projections for any year.

With the estimated households at 30 June 2001 the steps were:

1. For each Area Unit, multiply the 2001 Census "not a visitor only" private dwelling count by the estimated resident population at 30 June 2001, and divide by the 2001 Census usually resident population count.
2. Sum the estimates to give a total for each Territorial Authority.
3. Multiply the estimates from step 1 by the estimated households in each respective Territorial Authority at 30 June 2001, and divide by the estimates from step 2.

To derive the household projections at 30 June 2006 the steps were:

1. For each Area Unit, multiply the 2001 Census "not a visitor only" private dwelling count by the projected resident population at 30 June 2006, and divide by the 2001 Census usually resident population count.
2. Sum the projections to give a total for each Territorial Authority.
3. Multiply the projections from step 1 by the projected households in each respective Territorial Authority at 30 June 2006, and divide by the projections from step 2.

Repeat the above three steps to derive household projections for 2011, 2016 and 2021.

Appendix 3. Business Component Supporting Information

Figure A3.1. Valuation Database Total Floor Area to Lidar Volume Regression Analysis Results by Zone and Activity

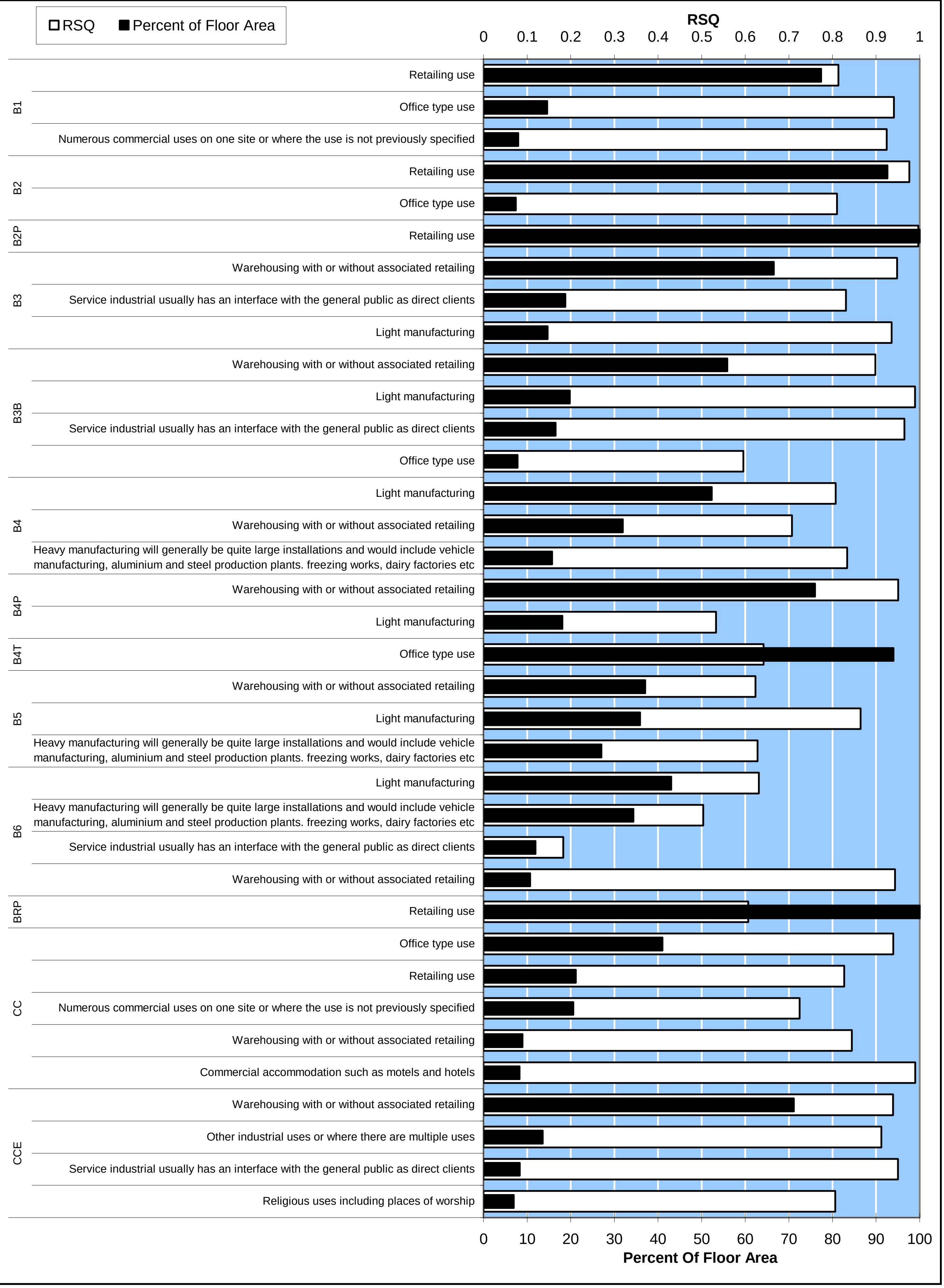


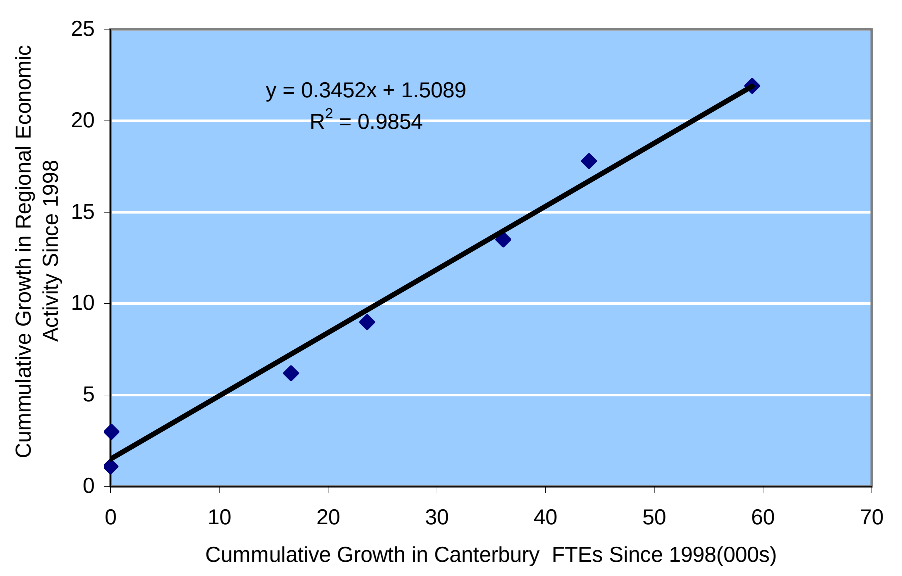
Table A3.1 Annual Area of New Commercial Floor Area in Christchurch (Square Metres)					
	Zone Groups				
June Year	Central Commercial (CC and CCE)	Central Industrial (B3 and B3B)	Suburban Commercial (B2)	Suburban Industrial (B4, B5 and B6	Total
1992	5,343	7,636	12,628	46,243	71,850
1993	4,685	11,729	8,696	46,113	71,223
1994	13,305	38,941	41,729	84,172	178,147
1995	6,299	44,898	7,800	115,007	174,004
1996	30,015	34,398	16,479	129,362	210,254
1997	14,247	13,239	1,842	129,335	158,663
1998	75,891	16,035	18,828	115,727	226,481
1999	9,343	19,312	9,738	113,747	152,140
2000	14,366	11,573	13,683	139,882	179,504
2001	27,152	18,492	8,063	130,446	184,153
2002	8,646	11,802	35,959	132,429	188,836
2003	1,722	19,044	26,583	149,471	196,820
2004	4,303	6,222	56,119	161,245	227,889

Source: CCC Building Consent Records.

Table A3.2 Summary of Zone Components used for distributing Projections at a Sub City Level			
Zone Groups	Percent Infill	Percent Vacant	90th Percentile of Floor Area to Site Area Ratio
B1	100	0	0.696
B2	100	0	0.764
B3	90	10	0.718
B3B	45	55	0.794
B4	45	55	0.602
B4P	50	50	0.214
B4T	5	95	0.321
B5	45	55	0.622
B6	75	25	0.092
BRP	100	0	1.430
CC & CCE	97	3	2.938

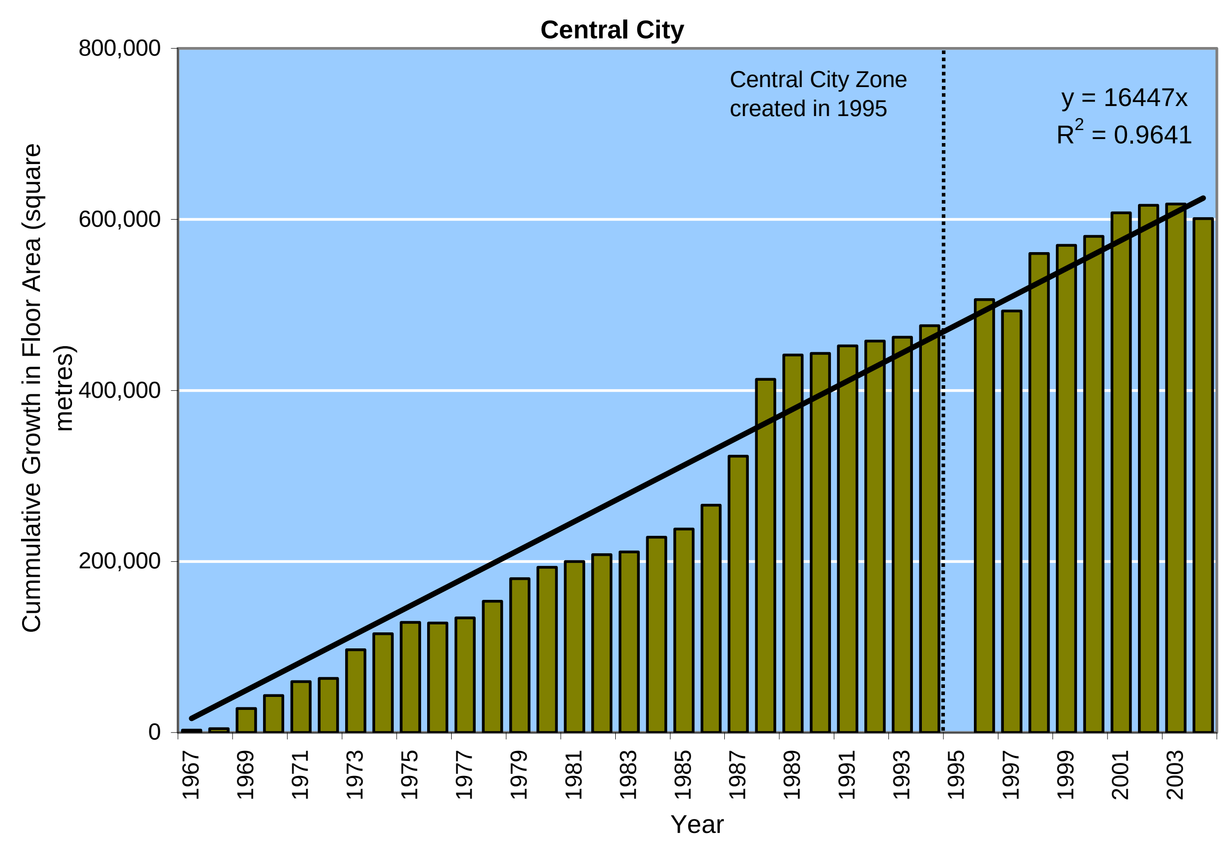
Source: CCC Building Consent Records, Business Floor Area and GIS Cadastral information

Figure A3.3. Comparison of Regional Economic Activity Index and Growth in Canterbury Employment



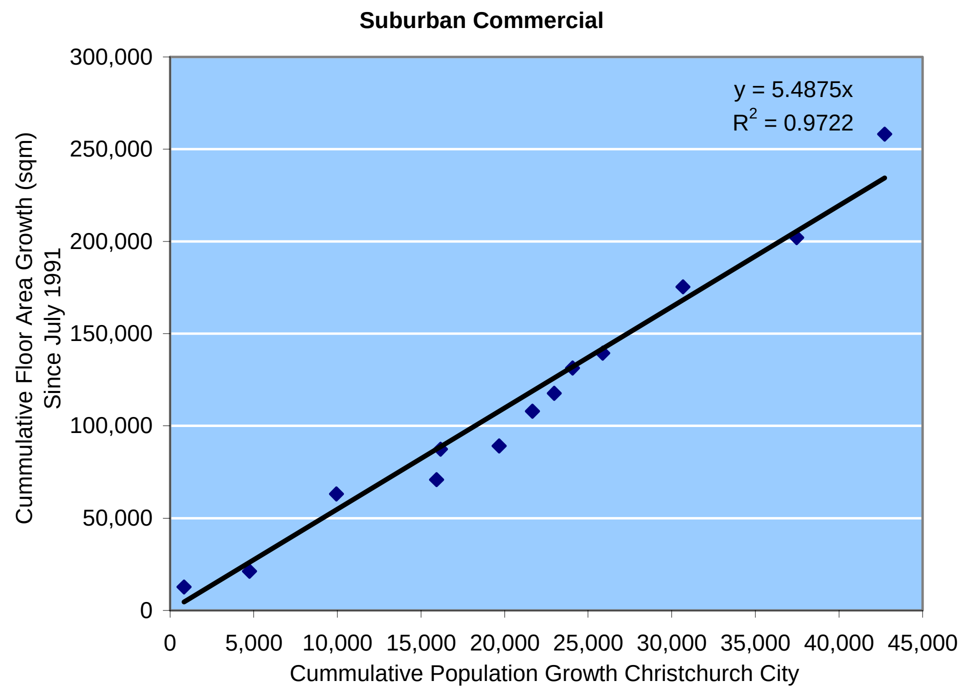
Source: National Bank Regional Economic Activity Index, NZIER Canterbury Employment

Figure A3.4. Growth Rate of Central City Floor Area since 1996



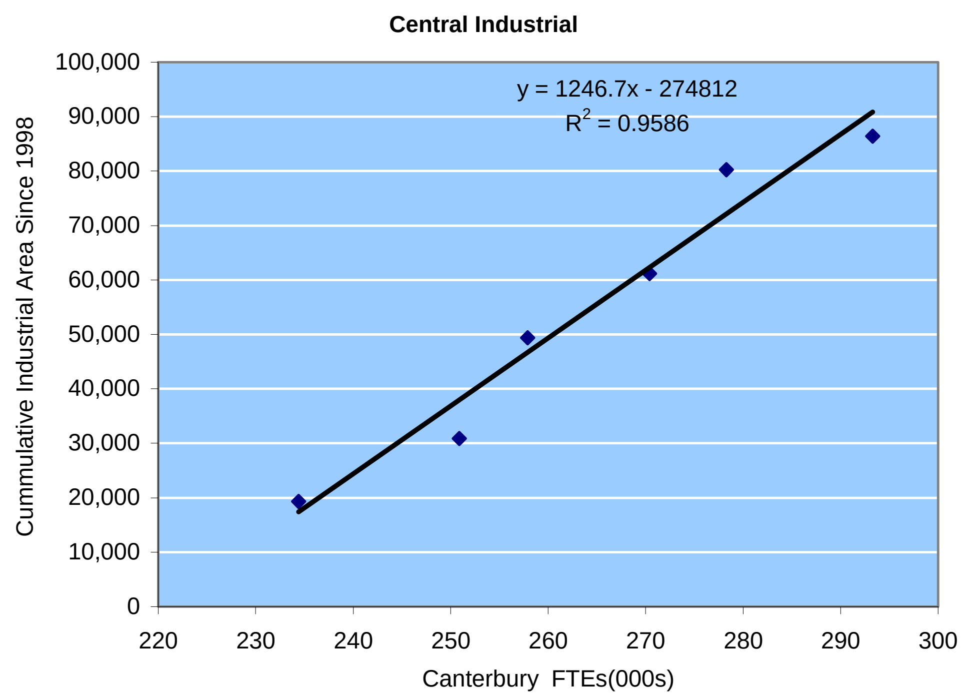
Source: Christchurch City Council, Building Consent Records

Figure A3.5. Growth of Suburban Commercial Floor Area to Christchurch Population Growth



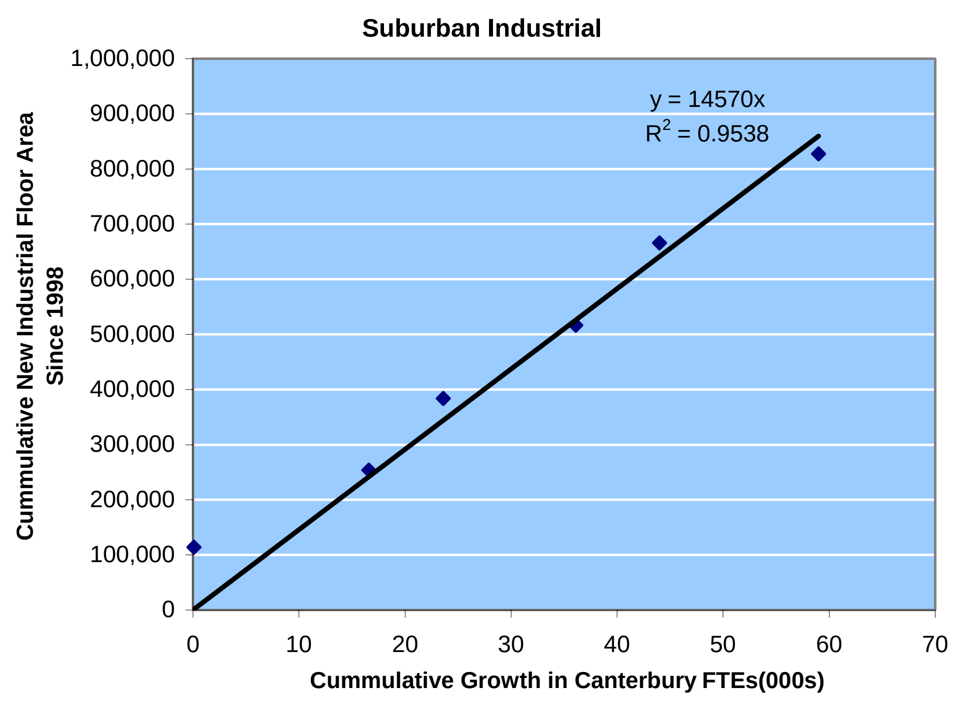
Source: Christchurch City Council, Building Consent Records, SNZ Subnational Population Estimates

Figure A3.6. Growth of Central Industrial Floor Area to Canterbury Employment Growth



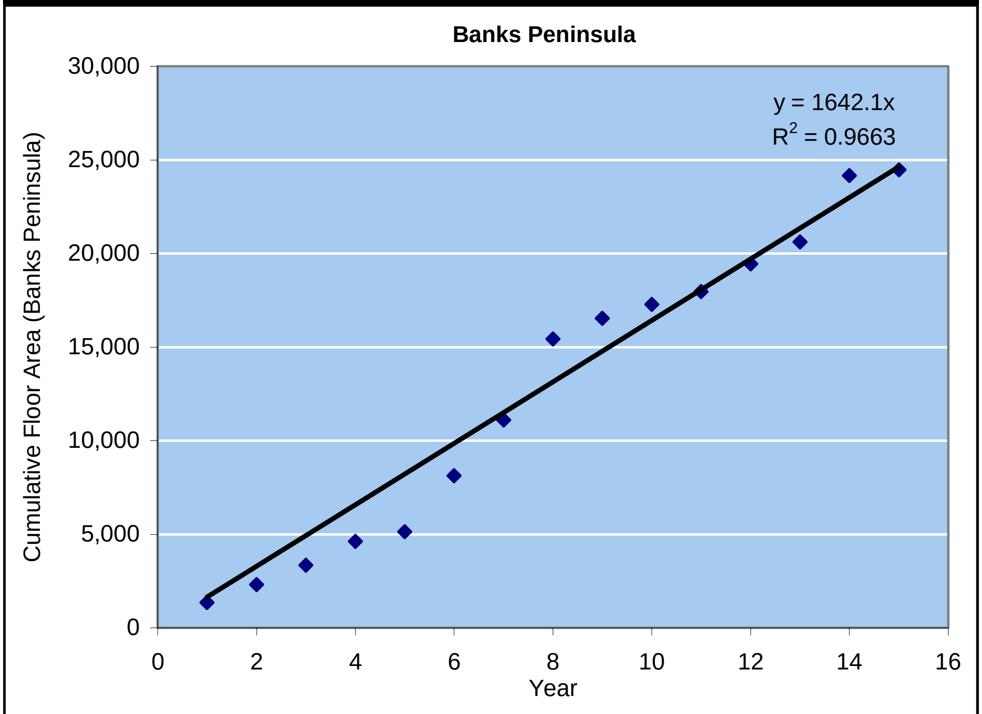
Source: Christchurch City Council, Building Consent Records, NZIER Canterbury Employment Projections

Figure A3.7. Growth of Suburban Industrial Floor Area to Canterbury Employment Growth



Source: Christchurch City Council, Building Consent Records, NZIER Canterbury Employment Projections

Figure A3.8. Growth of Banks Peninsula District Floor Area over Time



Source: Statistics New Zealand, Building Consents Data