The impact of secondary school enrolment schemes on school desirability, academic achievement and transport

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By Andrew Devonport

Department of Geography, University of Canterbury

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Abstract

Parental choice in selecting schools is usually subjective and research has previously relied on the accuracy of parental surveys and opinion to identify factors that make a school desirable. This thesis used a quantitative approach to investigate the potential relationship between a secondary school's desirability and some factors that may influence parental choice. Parental choice can also have transport implications, where students travel further to school if their closest school was bypassed. Because of the potential transport implications this thesis also sought to quantify the environmental impact of students travelling further to school. To investigate this, secondary schools in Christchurch, New Zealand were utilised to test these possible relationships and transport implications

To test the relationship between school factors and desirability, the percentage of a school's roll that came from outside of its zone was used as a proxy for desirability, with a school attracting a high proportion of its students from outside of its zone was assumed to be desirable. The out-of-zone percentage was then tested using linear regression within R against school factors, the factors tested being National Certificate of Educational Achievement results, frequency of Education Review Office reports, roll size, decile rating, and school leaver's rate. To calculate the environmental impact from parental choice, the 18,768 state secondary school student address points from the Ministry of Education March 2015 roll return data for the Greater Christchurch area, were used within ArcGIS© Network Analyst in order to calculate the distance that could be saved if each student was allocated to their closest state school instead of where they went to in March 2015

The regression found that the second highest achievement score (Merit) rates at all three National Certificate of Education Achievement levels positively correlated with out-of-zone percentage, as did schools with a decile rating of 9. Frequency of Education Review Office reports and roll size did not significantly correlate, and the school leaver's rate negatively correlated with the out-of-zone percentage. The transport analysis found that a sum of 79,021.8km could be saved per day if each state secondary student went to their closest school, equating to a decrease of 156.6kg of CO_2 emissions per day.

The characteristics of a school that had a relationship with a school's out-of-zone percentage can be used by school's or government authorities to better understand what may attract students to schools they are not within zone for. Quantifying the distance saved if each student went to their local school highlights some of the benefits that can result from better understanding why some schools are preferred over others.

Abbreviations

AGHS	Avonside Girls High School
CBHS	Christchurch Boy's High School
CGHS	Christchurch Girls' High School
CO	Carbon Monoxide
CO_2	Carbon Dioxide
ERO	Education Review Office
LSOA	Lower Super Output Area
MoE	Ministry of Education
NCEA	National Certificate of Educational Achievement
NO_2	Nitrogen Dioxide
NZ	New Zealand
NZGD	New Zealand Geodetic Datum
NZOGPS	New Zealand Open GPS
NZQA	New Zealand Qualifications Authority
O_3	Ozone
PM_{10}	Particulate Matter 10 micrometres or less in diameter
PPTA	Post Primary Teachers Association
SBHS	Shirley Boys High School
SES	Socio-Economic-Status

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1. Introduction

This thesis explores the potential relationship between a school's out-of-zone percentage and it's characteristics, to give insight into which characteristics may make a school more desirable; out-of-zone percentage being used as an indication of school desirability. The relationship was studied by examining secondary schools in the greater Christchurch area of New Zealand. Parents may bypass their local school in favour of desirable schools, and so this thesis also seeks to quantify the environmental impact that this bypass of local schools can have, and to what extent it could be reduced if all students went to their closest school.

School attendance is compulsory from the age of 6 until 16 in New Zealand (Education Act 1989, s 20) thus school enrolment schemes are a tool utilised to ensure that schools do not become overcrowded. The scheme achieves this by defining a geographic boundary in which students within this boundary are guaranteed enrolment at a school. If there are any spaces left after in-zone students have enrolled the scheme dictates who is then eligible for enrolments from outside the zone until the school is filled (Ministry of Education, 2011). Secondary schools can be seen to be of differing educational quality with some parents avoiding some schools in favour of ones that are perceived to be superior, offering better academic outcomes for their students (Bernal, 2005; Waslander and Thrupp, 1995). A good education can be seen to be especially important in secondary school as the results from National Certificate of Educational Achievement (NCEA) exams taken in Years 11 to 13 contribute to whether a student is eligible to attend university. This parental choice in secondary schooling can lead to an enrolment scheme being implemented on a school to ensure they do not become overcrowded, and also to indirectly limit the number of schools running under capacity by pushing students back to the school in their local area. School zones can be contentious however, as a proportion of school funding is based on the number of students attending that school (Ministry of Education, 2016), and residing within zone of a well performing school may be preferred by parents (Figlio and Lucas, 2004). The desirability of being within a good school's zone translates into an economic benefit, where properties within the zone have higher house prices than those outside the zone (Anthony, 2016; Murphy 2016 June 24), resulting in any amendment or change to a zone seeing staunch opposition from the school community (NZ Herald, 2016).

1.1 Christchurch Context

Christchurch is the largest city in the South Island of New Zealand and is the main urban centre in the Canterbury region. As of June 2016 Christchurch has a population of 375,000 people (Christchurch City Council, 2016). The March 2015 school roll return data[1] shows 24,246 students attend the 29 secondary schools within the Greater Christchurch Region. Greater Christchurch is defined in this thesis as Christchurch city, Kaiapoi, Rolleston, Darfield, and Lincoln. Where Greater Christchurch students attend school, however, has changed dramatically in recent years.

The Canterbury region experienced major earthquakes in 2010/2011 which displaced families and caused some schools to be relocated either temporarily or permanently. This population shift altered enrolment patterns. Western suburban schools had an influx of students from the Eastern suburbs, or site shared with damaged schools from the Eastern suburbs. Five years on from the Canterbury earthquakes repairs or relocations of affected schools are nearing completion; with Aranui High School's renovation and change into Haeata Community Campus set to be completed in early 2017, and Avonside Girls' High School and Shirley Boys' High School moving into their new site in Parklands early in 2019. Enrolment patterns therefore may change again as recovery continues. But the earthquakes have influenced this thesis as it stemmed from an examination of a potential new catchment for an Eastern suburban school refurbished after the earthquakes.

1.2 Rationale for thesis

The examination showed that the addresses of some of the students currently attending the Eastern suburb school in Christchurch were more than five kilometres (km) from the school. With the added publicity of other schools in Christchurch having a large percentage of their roll coming from out of their designated zone (Law, 2016), this observation raised the question of why some schools were attracting so many students from far away, despite there being schools closer to the student's place of residence. The primary rationale for this thesis is therefore to see why, in a Christchurch context, students may be travelling long distances to get to school.

This attraction that some schools have can result in students travelling further to school, potentially adding more pollution to the environment and increasing traffic congestion if the students are driven to school. Understanding why some schools are favoured over others can reduce the potential environmental consequences by giving information to schools on why they are being avoided and hence an idea on what the school can change to become more desirable to parents and

[1] March 2015 Roll Return data was supplied by the Ministry of Education through an official information act request

students. The secondary rationale for this thesis was therefore to calculate what distance could be saved if each student went to their closest school.

1.3 Aims and Objectives

The aim of this research is to examine the impact school characteristics have on school choice or the schools desirability, and the transport impacts of this school choice in Christchurch, New Zealand. In this thesis a school's out-of-zone percentage has been used as a proxy for a school's desirability, with more students attracted from outside of the zone implying there is something more desirable about the school.

To answer this aim this research seeks to firstly, examine the link between secondary school characteristics and the percentage of its roll that are out-of-zone in Christchurch New Zealand, and secondly, to then quantify the distance that students currently travel to school and how it would compare if each student went to their closest school. Because individual factors such as a parental socio-economic-status and ethnicity have been suggested to influence parental choice in the past (Garner and Raundenbush, 1991;Kim and Hwang, 2014; Rumberger and Willms, 1992), this thesis will also test a neighbourhoods out-of-zone percentage against its Māori percentage and median income to account for the possibility that ethnicity and income could also influence parental choice.

This research into school enrolment trends and transport implications were hence guided by the following questions:

1) Which school characteristics, such as academic achievement, socio-economic status, or perceived school desirability, correlate with a school's out-of-zone percentage?

2) Which neighbourhood effects, such as socio-economic status, income, or ethnicity, correlate with an area's out-of-zone percentage?

3) What distance of travel could be saved if all secondary students went to their closest school?

2. Literature Review

2.1 School Enrolment Schemes and Zoning

Although every student has the right to attend a state funded school under New Zealand law, this does not account for the practical problem of overcrowding; with every school only able take so many students while still running effectively. As a result the government introduced school enrolment schemes, or home zones, as a mechanism to prevent overcrowding, while still allowing students the right to go to their local school. These enrolments schemes utilise catchment (zone) boundaries to guarantee enrolment if students are within zone. Zones are determined by schools with collaboration and consultation with the Ministry of Education (MoE), with the MoE approving the zone allowing it to be implemented only if it meets the purpose of an enrolment scheme under the Education Act 1983 (Ministry of Education, 2011). The purpose of an enrolment scheme under the Act (1983) is to avoid overcrowding or the likelihood of overcrowding, ensure the selection process for enrolment is fair and transparent, and allow the network of schools to be effectively managed (Education Act 1989, s 11A1). The enrolment scheme, to the best of its ability, must also not exclude local students, defined as excluding no more students than necessary to prevent overcrowding (Education Act 1989, s 11A2). The 'not excluding local students' section can cause issues and is why school enrolment schemes are managed as networks instead of single entity. One such issue is that a school must allow room for all students within their zone, as in local students, even if these students currently attend another school (Ministry of Education, 2011). This can result in some schools being required under law to have places open if a local student decides to switch schools part way through the school year, which may result in a reduction in funding due to less students attending the school. However, if these places are not open and are needed then the Education Act has been breached by the school, usually imposing some kind of MoE oversight, such as a representative overseeing and having authority over the school's enrolment process.

Sometimes an enrolment scheme can be seen negatively by schools, as some funding is directly tied to the number of students at the school (Ministry of Education, 2016). However, before more classrooms are built to prevent overcrowding, an enrolment scheme would be imposed on the school if the neighbouring schools had room. The criteria of having open places for local students can make zones seem unfavourable to some schools. When a school needs an enrolment scheme, because schools are managed as a network, other schools schemes may be reduced to accommodate this new zone. This can upset local residents and cause political backlash as school zoning can have a direct influence on house prices; houses being more expensive within zone of a desirable school (Anthony, 2016; Murphy, 2016 June 24). The effect on house prices can see people living in the area in question object to a zone being changed or implemented, to the point of taking legal action against a zone (NZ Herald, 2016). Further, because of the politician's need for public support this can see zone changes which could benefit schools and students stall or be scrapped altogether. Consequently the real estate market keeps a close eye on school zones as a marketing tool to sell houses and they are interested when schools wish to have zones changed. One such change to schools could be because of population shifts in Christchurch post-earthquake.

School zoning is one mechanism for regulating school overcrowding. However, previous research have suggested that a free market education system can benefit the students more effectively (Ball, 1993; Chubb and Moe, 2011), because if a service is perceived to be good it will be desired and expand; and if the service is bad it will be avoided and will struggle (Niggle, 1985; Scherer and Ross, 1990). Some researchers advocated the removal of school zones in the public sector (Ball, 1993; Beaven 2003), because when applied the free market system allowed any student to go to any school. This system encouraged schools to offer the best education possible or face closing down when enrolments fell, known as education natural selection (Chubb and Moe, 2011). Natural selection can encourage not only an atmosphere of competition between schools, but also competition between students for limited places in the schools that are perceived to be performing well; a potential contributor to school desirability. This system is similar to the private school system, in that it puts more emphasis on schools to please parents and students (Ball, 1993).

Waslander and Thrupp (1993) investigated the effect of free market education when it was implemented in New Zealand in 1990, and found that removing the zones caused a mass exodus from perceived low performing schools in favour of the perceived better performing schools. The top performing and more desirable schools were not affected by the removal of zones as they were already over-subscribed, and were thus unable to take the additional students from the low performing schools. While these schools could have expanded, in the opinion of Waslander and Thrupp (1993), this expansion would have changed the physical, social, and personnel dynamics of the school, increased classroom's would lead to increased infrastructure and maintenance costs, an increase in students would lead to greater anonymity and potential negative behaviour, and an increase in teacher numbers making it difficult to ensure that teachers met the educational standards of the school. Free choice also appeared to further divide schools by enabling polarisation based on ethnicity and socio-economic status; referred to often as 'white flight' (Waslander and Thrupp, 1993). 'White flight' referred to the tendency for mostly wealthy Europeans to bypass the closest school if the area consisted of predominately lower income minorities (Frey, 1979). Furthermore some poor performing schools suffered as they were forced to spend money on advertisement instead of actually improving their quality of education (Waslander and Thrupp, 1993). The free market in this respect fosters greater choice and is supposed to improve educational performance. However Waslander and Thrupp (1993) found that the system favours affluent parents who have the resources to take advantage of parental choice, further segregating schools on ethnic and financial grounds.

Geographic boundaries for school enrolment schemes were re-established in 1998 in schools at risk of overcrowding (PPTA, 2014). An examination of current Ministry of Education policy (Education Act, 1989) appears to show that the current zoning system in New Zealand is a mix of free market and zoning schemes. All students must have a place at their spatially convenient school, but schools may have out-of-zone students if there is sufficient space. Under the Education Act (1989, s 11F) there is a process to ensure out-of-zone students are enrolled fairly. First Priority goes to applicants in a special programme run by the school which offers a form of special education or overcomes an educational disadvantage, second to siblings of current students, then siblings of former students, children of former students, children of the school board members or employees of the board, and final priority is given to everyone else. If there are more out-of-zone applicants than spaces at the school then a ballot is conducted on the priority groups for the spaces available after the priority group above them has taken their spaces. A mixed system allows parents to have some choice over what school to send their children to, while in theory ensuring everyone can have access to the education they wish. The Canterbury-Westland Secondary Principals Association was recently quoted in The Press as "advocating for every child to be in-zone for at least two state schools" (Murphy, 2016 April 28). The Association claimed that this would allow parents increased choice in which school to send their child. Such an idea however, would see zones overlap, meaning that both schools would have to keep an open place for the same students, forcing some schools to run under capacity, or risk being overburdened; especially with late enrolments or a sudden shift in public opinion (PPTA, 2014).

The point raised by the Canterbury-Westland Secondary Principals Association that parents should have increased choice in their child's school (Murphy, 2016 April 28), suggests that there is something fundamentally different between certain schools. One factor that may influence a parent's choice of school is the school decile system in New Zealand (Hill, 2016). The decile system categorises schools based on five socio-economic criteria: household income, skill level of parental occupation, household crowding, parental educational qualifications, and if parents receive government social welfare benefits (Ministry of Education, 2015a). These criteria are applied at meshblock level that the students attending the school live in, and are then used for funding purposes. A meshblock is a geographical boundary that provides a small area for sampling and collection of geographical data for statistical purposes, and to form the smallest building block for the New Zealand electoral system (Statistics New Zealand, 2016). Meshblocks contain the aggregated average or count statistics of residents who live within them, so that information can be used from the national census without infringing on an individual's privacy. If a meshblock has such a small population that an individual's information could be identified then the data of that meshblock is made confidential. As of the 2013 there were 45,989 meshblocks in New Zealand, 5,876 making up the Canterbury region. While different information in the meshblocks is made confidential for the 2013 median income, 6,168 meshblocks were confidentialised . Schools with lower deciles or low SES receive more funding, as policy based on past trends has indicated a higher financial need at these schools (Ministry of Education, 2015a). Some parents see a lower decile school as being less desirable for financial and non-financial reasons (Moir, 2016), such as having a greater proportion of 'problem children' attending these schools (Ball, Bowe, and Gewirtz, 1996). Chris Hipkins, the Labour political party's education spokesperson, agreed that the stigma around low decile ratings contributed to certain schools being avoided, and decile was used by parents as an indicator for school quality (Hill,2016)

In the United Kingdom school funding is similarly allocated based on a per student basis, with the bulk of education funding being provided to the local authority who then distributes it to the schools in their area. Each local authority has a slightly different formula for how much funding a school is allocated, but in general a minimum per pupil amount based on age range (primary or secondary) and deprivation are the main factors used. Other factors include children in care, prior attainment, and English as an additional language (Roberts, 2016). Deprivation in the United Kingdom is measured by the percentage per Lower Super Output Area (LSAO) of 0-15 year olds living in income deprived households, defined as either receiving income support or an income below 60% of the national median income before housing costs (Local Government Association, 2016). The United States takes a completely different approach from the United Kingdom and New Zealand. In the United States nearly half of a school's funding comes from local property taxes; meaning the wealthier areas receive more funding (Biddle and Berliner, 2002). This type of funding system causes an inequality in the resources that schools have access to, with public schools in the wealthier middle class areas having adequate funding, while the poorer areas receive significantly less funding. Policy and funding however, varies between states, with some states adopting a more progressive financial system that gives more funding to low income area schools (Richmond, 2015). Different school funding schemes can result in different preferences when it comes to school. Funding schemes for schools in parts of the United States can see schools be desirable as they are both in a high SES area, and receive more funding. In New Zealand and the United Kingdom, however, the policy of low SES schools receiving more funding can negate the potential attraction for parents to send their child to a school with more resources, as the stigma around low SES schools can outweigh the possible benefits of increased funding.

2.2 Parental Choice

2.2.1 Socio-Economic Status (SES)

The consequences of a disparity in funding and financial resources was observed in previous multinational research, which found that schools in low SES areas had lower rates of academic achievement than their higher SES counterparts (Sampson, Morenoff, & Gannon-Rowley, 2002). One consequence in New Zealand was parents bypassing the local school if it was low SES in favour of a more desirable school in a potentially wealthier and out-of-zone area. This bypassing of lower SES schools can see further academic decline in these low SES schools, with potential high achieving students in the area being diverted to other schools, and fewer students leading to reduced funding a school can receive (PPTA, 2014). School funding is complicated with many different factors such as special needs, property maintenance, and staff wages all contributing to a schools overall funding. However, some of the operational funding is based on the number of students a school has, coupled with the schools decile rating (Ministry of Eduation, 2016). If parents exercise choice to go to perceived better quality schools these schools receive more funding than the lower quality schools (PPTA, 2014), further increasing the social divide between schools. This is because while lower deciles may get more money per student, if there are fewer students then the increase in funding rate per head will not make up for the loss of students.

To investigate the effect of SES and educational achievement, Deluca and Rosenblatt (2010) used a housing voucher system that physically moved low income families into high to middle class areas. Deluc and Rosenblatt's (2010) findings suggested that while proximity to good schools may increase academic achievement, the family situation and the parents attitude toward education may have a larger influence on the educational prospects of low income households, and that greater information about potential schools should be provided to parents in order to improve student academic performance. Similarly Schneider et al. (1997), noted that enabling some degree of choice over public schooling options would increase parental involvement in their children's education. An increase in parental involvement leading to an improvement in student academic performance was referred to by Schneider (1997) as increasing social capital to benefit public education. Kim and Hwang (2014) found similar results in South Korea when they investigated whether parental choice would increase the parents' participation in the school. They found that individual factors such as the student's academic achievement, parental SES, and the parents support for their children's education influenced parents' participation more than institutional factors. Kim and Hwang (2014) concluded that it was the willingness of parents to choose, and their involvement in their children's education that increased the child's academic performance, and hence the effectiveness of that education.

Bernal (2005) looked at the types of people in Spain who were more likely to exercise choice in schooling. Bernal (2005) found that upper and middle class parents in both public and private schools in Spain exercised greater choice and favoured private schools or well performing public schools, while the working class and underprivileged favoured the closest public school available (Bernal, 2005). Hastings, Kane, and Staiger (2005) came to the same conclusion in the United States, where higher income parents focused on academic performance of schools, while lower income parents favoured proximity. Schneider (1998b) concluded that higher income parents in the United States also have access to greater levels of information and resources through their peer networks.

While these studies suggested that higher SES parents cared more about academic performance and thus strategically placed their children in the academically best schools, Schneider (1998a) suggested that lower SES parents prioritise a different set of values in education in the United States. These values included higher degrees of discipline and high standardized testing, due to the belief that the tests lead into tertiary education and good employment. High SES parents conversely were seen to value more progressive education. The high SES parents placed less importance than low SES parents on standardised testing scores, instead favouring more subjective ways of evaluating student performance. Research suggests that parental expectations, experiences, and ideals influence the school they send their children to rather than the notion that wealthier parents care more about their children's education (Bernal, 2005; Hastings Kane, & Staiger, 2005; Schneider et al., 1998a). However, Bernal (2005) suggested that wealthier parents have greater financial and social resources allowing for more opportunities to strategically place their child in well performing schools, in contrast to less affluent parents. Schneider et al. (1998b) found a similar result in regards to low SES parents, finding that, on average, low SES parents did not have accurate information about objective conditions of the schools. However, Schneider et al. (1998b) also commented on the importance of having parental choice when it came to state run schools, even if the low SES parents were not participating, as the parental choice of the middle and high SES parents would still encourage an atmosphere of competition and hence improvement among schools.

2.2.2 Ethnicity

In many of these studies lower SES and minorities were treated as interchangeable. This was especially the case in the United States research where the ethnic minorities were often referred to as a large proportion of low income families, with ethnic minority students performing worse than their non-minority peers, and being disadvantaged in educational choice because of their SES (Rumberger and Willms, 1992; Ogawa and Dutton, 1994; Schneider et al., 1998a;). It was interesting to note that in the European studies ethnicity was not a large factor in parental choice, and instead social class and economic deprivation were linked in relation parental choice and educational attainment (Bernal, 2005; Garner and Raudenbush, 1991). The addition of ethnicity within studies relating to deprivation in the United States can lead to ethnic segregation, where non-minority parents avoid schools simply because it is in a minority area, or the school has a high proportion of minority students (Rumberger and Willms, 1992). This trend can be seen in New Zealand as well where Māori and Pasifika Peoples are ethnic minorities, with previous research stating they had higher levels of deprivation and lower SES than NZ Europeans (Alexander, Genc, and Jaforullah, 2001), and also had lower educational attainment (Marie, Fergusson, and Boden,2008). This thesis will test for correlation between a meshblocks out-of-zone percentage and it's Māori percentage, income, and deprivation score to see whether the individual ethnicity and SES factors do have a relationship with parental choice like the previous research suggests; in this thesis meshblock out-of-zone percentage was used to indicate the level of parental choice used in the area.

2.2.3 Academic Achievement

Academic achievement has been raised as an important factor in parental choice within previous research (David, 1994; Kim and Hwang, 2014). Ensuring their child does well academically was suggested to be important due to the perceived advantages that good grades presented later on in the child's life (Kim and Hwang, 2014) . Because of this a school's academic history, ethnic composition, or decile rating can all influence a parent's opinion on whether a school will offer their child a good education (Rumberger and Willms, 1992), and ultimately whether the parent should send their child to that school or choose a different school (David, 1994; Hastings, Kane and Staiger, 2005, Schneider et al., 1998b). The qualities a school possesses coupled with the proximity of the parent and the parent's circumstances can all lead to a decision being made about the overall quality of a school (Waslander and Thrupp, 1995).

School quality issues are a discussed recurring theme in the news media in New Zealand. Hill (2016) suggested that an education apartheid was looming due to the increased number of students going out-of-zone for their schooling, quoting parents "don't believe their local school is the best option". Hill (2016) also quoted parents who said that their local schools' "academic statistics and the way the curriculum was taught" was a factor influencing their decision to send their child to a different school. The Press also ran an article which focused on the high number of students at Burnside High School who were out-of-zone (approximately 39% of the roll) (Law, 2016). Law (2016) raised the point that taking a large number of out-of-zone pupils can negatively affect other schools, attracting promising students away from other local schools. This recent publicity on out-of-zone students suggests that the issues researched in the past on parental choice, educational attainment, and school quality are still ongoing.

Although the New Zealand MoE have educational guidelines for what is essential for schools to teach and to what level (Ministry of Education, 2015b), there are still some perceived differences between schools. These differences in past research have been attributed to differences in the socio-economic status (SES) of the school area, values and moral teachings of the school, or the academic performance of students in the school (David, 1994; Waslander and Thrupp, 1995). A perceived difference in school quality, such as academic achievement, school size, and decile rating, can cause parents to see some schools as prestigious and of good quality and other schools to be avoided (Waslander and Thrupp, 1995). The ability of parents to choose between schools raises the question of what criteria do parents think are important and hence what distinguishes one school from another. Several studies on parental choice and schooling in the past have pointed to school academic quality, and socio-economic status as deciding factors in parental choice (Bernal, 2005; David, 1994; Kim and Hwang, 2014). These studies however, obtained their information through surveying the parents, which can be open to response and sampling bias (Newcomer and Udry, 1988; Whitehead, 1991). Response bias is where only those interested in the topic may respond to the survey or not be truthful due to social pressures, while sampling bias is where the number of responses obtained in the survey may not accurately representing the entirety of parents (David, 1994). Sampling bias was evident in Scheider et al. (1998a) which had 1600 responses from the approximately 7.6 million people who resided in New York city (United States Department of Health, 2007) . While response bias may have been present within Bernal (2005) and David (1994) because of the possible social stigma around admitting that ethnicity or Socio-Economic Status was a factor in school choice.

This thesis differs from previous research in that it is comparing factual and statistical information of schools to the school enrolment patterns, instead of the surveys on school choice which have been previously used; enrolment patterns being used as an indicator of school desirability. Using factual information and statistics on the schools provides an observable relationship between characteristics and school enrolment patterns, that can be easily obtained and compared at any given time period. Surveys, however, can be time consuming, only give the opinion of people who respond, suffer from response bias, and only apply to the set moment in time the surveys were taken. This thesis will add to the debate of parental choice by examining the relationship between statistics obtained on each school and comparing it to the school enrolment patterns, which is information potentially more accessible to the schools and authorities in New Zealand that manage the schools.

2.3 Transport and enrolment

Parental choice can lead to some schools being bypassed, leading to some schools having a high number of out-of-zone students (Law, 2016). Students going out-of-zone for schooling can result in some student's having to travel long distances to get to school, the increased distances resulting in more motor vehicle transport and a decrease in walking and cycling . This can have significant social, environmental, and health consequences (De Nazelle et al., 2011; McDonald and Aalborg, 2009; Wilson, Wilson, and Krizek, 2007). The increase of distance travelled to school can result in more vehicles on the road at certain times, in particular around schools at the beginning and end of school time. This increase in traffic around schools at peak times is known as the 'school run' (Kingham, Sabel, and Bartie, 2011), and has become more prevalent since the 1990's due to increased access to motor vehicles and increased child safety concerns (McDonald, 2005; McDonald, and Aalborg, 2009). An increase in traffic increases road congestion and decreases child safety (Wilson, Wilson, and Krizek, 2007), as well as increasing the travel time of other road users. Higher vehicle numbers also produce greater quantities of air pollutants such as $C0_2$, CO, $N0_2$, and PM_{10}, which are linked to an increase in prevalence of respiratory problems, and aggravate symptoms in those who already have a respiratory disease (D'Amato et al., 2010; De Nazelle, 2011). The aggravation of respiratory problems by vehicle pollution can also translate to a direct financial cost to government (Quah and Boon, 2003). The increase in pollution can lead suffers of respiratory disease going into hospital more often, with the government paying money in healthcare for each hospital visit (Schwartz, Slater, Larson, Pierson, and Koenig, 1993). Although there could be health benefits from exercise if students walked further to school, in reality parents with safety concerns prefer to drive their children (Sonkin et al., 2006). No matter which transport choice is taken, walking, cycling, or private motor vehicles, all children are exposed to more pollution with more vehicles on the road. Even if the child is in within a motor vehicle, previous research has found the child would be exposed to the same amount of pollution levels whether they were walking on the footpath or cycling on the road, showing the difference in pollution exposure based on transport choice to be negligible (Chertok et al., 2004; van Wijnene et al., 1995).

In a broader context, increased pollutants from transportation, for example greenhouse gases ($C0_2$, CO, O_3), contribute to climate change (Ramanathan and Feng, 2009). Student safety, respiratory health, and the quality of the physical environment will benefit from limiting the number of vehicles on the road. Every student going to their local school reduces the distance students need to travel, and hence potentially decrease the number of vehicles on the road. Müller, Tscharaktschiew and Haase (2008) investigated the transport implications of school choice in Saxony Germany, where there was no school zoning policy. When schools were shut down students were forced to travel further to school. Müller et al. (2008) found that proximity, school authority type (public or private), reputation of school, and tuition fees were significant factors when parents had to choose a new school. From the transport analysis Müller et al. (2008) also found that while the government saved money on school infrastructure and staff, potentially more was spent by the government on transport options for the students.

2.4 Summary

Parental choice can have an impact on school enrolment patterns and trends, with some schools being favoured over others. Previous researchers have suggested some factors that may influence a parent's decision on where to send their child, such as school academic achievement, morals and values, neighbourhood socio-economic status, and ethnic composition (David;1994, Waslander and Thrupp, 1995), with some individual factors of the parents such as income, ethnicity, values and beliefs also being given as possible influences (Garner and Raundenbush, 1991;Kim and Hwang, 2014; Rumberger and Willms, 1992). This research seeks to answer the question of what school characteristics make a school desirable in a Christchurch context; using the out-of-zone percentage of each school as an indicator of desirability. This differs from previous research in that it will use observable quantitative information and statistics on each school, instead of parental surveys which have predominately been used in previous research into parental choice (Bernal, 2005; David, 1994).

This research will also test whether the ethnicity and SES of neighbourhoods effect the proportion of students from the area who go out-of-zone for schooling, as previous research suggests that minorities and low SES people are less likely to exercise parental choice (Kim and Hwang, 2014;Rumberger and Willms, 1992; Schneider, 1998a).

Students bypassing their local school can also increase the distance students travel and hence contribute to environmental pollution and traffic congestion, due to more vehicles being on the road when transporting students to school (D'Amato et al., 2010; Kingham et al., 2011; Tscharaktschiew and Haase, 2008).Because of the impacts increased travel distances can have, this research will also investigate the distance that could be saved if each secondary school student in Christchurch went to their closest school.

3. Method

The following chapter covers the methods used to investigate the school enrolment patterns, compare the patterns of enrolment to school characteristics, and then calculate the potential distance saved if students went to their local school. The chapter first outlines the data used and their sources, and second, discusses the processing that was done to the data. Third, the regression analysis that was carried out and the methodology behind the transport allocation analysis are described.

3.1 Data Sources

School Roll Return data of secondary schools for March 2015 were obtained from the MoE. This was a MapInfo© table file which contained points at the address of each student, and also contained the demographic information associated with each student address point. This demographic information consisted of the student's gender, ethnicity, funding year level, zoning status, full time equivalent (FTE), boarding status, and which school the student attended. The student's name, date of birth, and address name were removed from the points in order to protect individual privacy. Altogether the data contained 28,337 secondary student records. These student's address points were only used to determine, the proportion of students at each school who physically resided outside of the zone, the roll size of each school, and to calculate the distances each student currently travels to school and the distance if each student were allocated to their closest school. This data and how it would be used within this thesis was given approval by the University of Canterbury Human Ethics Committee.

School locations as of April 2016 for all of New Zealand were obtained from the MoE as points. This was a MapInfo© table file which contained the point locations of the schools defined as the centre point of the school area, as well as the name, decile rating, type (primary or secondary), and authority (state, state integrated, or private) of each school. For this research the Greater Christchurch schools were extracted from the school dataset, which consisted of a total of 30 schools; 19 being state, seven state integrated, and four being private schools. The school locations were used when calculating the distance each student travelled to their current and closest school. The secondary school locations have not shifted in the last two years and so the data obtained was the most up to date at the time in regards to school closures (April 2016).

School Enrolment Scheme Polygons were obtained from the MoE. This was a MapInfo© Table file which contained the school enrolment scheme polygons for each secondary school in New Zealand, along with the name, type, and authority for each school. Similar to the school points the Greater

Christchurch school zones were extracted from this layer. However, only the state schools were used in the zone analysis due to the additional entry criteria that state integrated and private schools have. Additional criteria that excluded these schools were that private schools did not have zones, and the few state integrated schools that did have a zone saw it extended well beyond what could be considered a local catchment by state school standards; Marian College's zone extending out to the Southern Alps. The polygons represent the current home zone in effect as part of the school's enrolment scheme for each school as of April 2016, and are shown below in Figure 1. These polygons were used to calculate the in-zone and out-of-zone student proportions for each school. Home Zones as part of a school's enrolment scheme can see minor amendments over time and so the most up to date zones were obtained for the analysis at the time, this being April 2016.

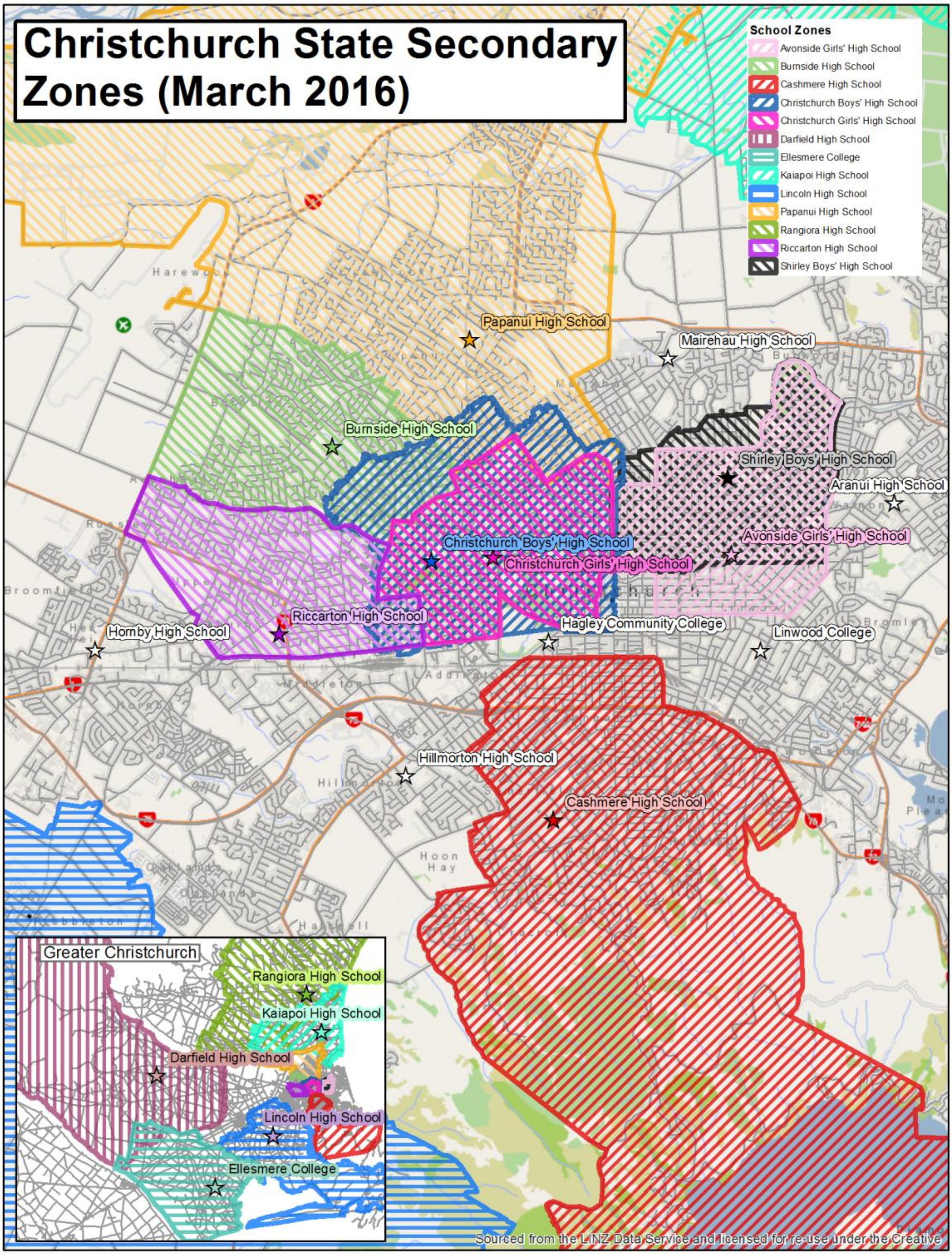

Figure 1:Greater Christchurch current enrolment schemes as of March 2016

NZQA 2014 Achievement Statistics were obtained from the New Zealand Qualifications Authority (NZQA). The NZQA achievement statistics showed the National Certificate of Educational Achievement (NCEA) rates per school and showed the number of students per school who received a not achieved, achieved, merit, or excellence NZQA endorsement in their NCEA Level 1, Level 2, or Level 3 studies. NCEA is the main nationally recognised qualification for secondary school students in New Zealand. These were used to calculate the percentage of students at each school who received each endorsement for each NCEA level. This percentage was used as an indicator of school quality, as schools with high not achieved percentages in NCEA would not be considered to be a high quality school; as many of their students would not be achieving NCEA. Schools with high achieved, merit or excellence rates however, would be considered to be of good quality; higher merit and excellence percentages suggesting the school is teaching their students above what is required to pass NCEA. The NCEA results are used in this thesis as the an independent variable to represent a school's academic reputation, to be compared against the school out-of-zone percentage.

The School Leaver's Rate was obtained from the MoE and showed the percentage of students for each school who left before their 17th birthday. This data was to complement the NZQA Achievement statistics in case any students did not appear on the achievement statistics due to the student dropping out of school or out of NCEA before the end of the year. The Achievement Statistics in this analysis are a proxy for how well the school is performing, and so dropouts who did not attempt NCEA would not necessarily show up on these Achievement Statistics, making a school appear more successful than they actually are. This is where the Student Leaver's data can account for this potential bias by giving the percentage of students per school who left before their 17th birthday and the level of qualification the student attained when they left the school system. This Leaver's data was given in percentages as not to infringe upon individual privacy, with the leavers under 17 who did not attain NCEA Level 1 being represented as a percentage of a percentage. For example if a school had 50% of its students leave before they turned 17 and 15% did not obtain NCEA Level 1, then the data only reveals that 15% of 50% of leavers did not obtain NCEA Level 1. Only the percentage of students who left before their 17^{th} birthday was used in the analysis as an independent variable instead of the level they attained when the student left school. This may ignore the very bright students who skipped years and completed NCEA Level 3 before their 18th birthday; 18 being the normal age of completing NCEA Level 3 if a student began schooling at 5 years of age. However, the number of students who would have had passed NCEA Level 3 before their 17^{th} birthday would have been small, and so the percentage of students per school that left before their 17^{th} birthday was used.

The Education Review Office (ERO) reports for each of the secondary schools in Christchurch were obtained from the ERO website and the dates on which each of these evaluations were carried out was recorded, spanning from 2004 to the date they were collected (April 2016). The ERO writes an evaluation and reports on the education and care of children in schools. The ERO reports are carried out per school roughly every three to five years unless there are issues found at the school during the report. If that is the case, then the report will be carried out sooner to ensure that progress is being made to remedy any issues observed. The ERO reports in this research are being used as one proxy for school quality. The assumption being made is that the more reports that are needed the less well the school may be performing.

The Census 2013 data and 2013 meshblock polygons were obtained from Statistics New Zealand. The 2013 census data was not originally joined to the 2013 meshblocks when obtained, possibly due to the large amount of data that the census contains. Each record in the census however, contains a meshblock identification which corresponds to an identification in the 2013 meshblock polygons. Because of this, the median income and deprivation score for each meshblock were extracted from the 2013 census records and joined with their corresponding meshblock polygon, based on ID number. This allowed the secondary student ethnicity and zoning status of each meshblock, when calculated, to be added to each corresponding meshblock. For this analysis, only the meshblocks which contained students attending the secondary schools in Greater Christchurch were used, equating to a total of 3488 meshblocks. Having this data associated to their corresponding meshblock allowed the out-of-zone percentage for each meshblock to be tested against the income, deprivation score and ethnicity percentage of each meshblock. The deprivation score is a rating of a meshblock into how deprived an area is based on income, home ownership, housing, employment, qualifications, family structure, and access to transport and communications (Atkinson, Salmond, and Crampton., 2014). These deprivation scores are subsequently grouped into deciles to make the decile rating, with the 10% highest areas of deprivation receiving a decile rating of 1.

To calculate the distances students travelled to school a road network analysis layer was obtained from GeoHealth Laboratory at the University of Canterbury, for the purpose of using within ArcGIS© Network Analyst. This network was originally generated as an open-source road network for the Ministry of Health for testing environmental exposures on health outcomes. Techniques from previous road network generation (Brabyn and Skelly, 2002) were used and built upon to construct the network, with road distance and travel time being incorporated on each stretch of road digitized in the network. Route times and distances using this network were tested against the same routes using Google Maps, and the times and distances were found to be not significantly different. Modelling the time it takes to complete a journey can be complicated, with weather, time of day, and unexpected accidents contributing to road congestion and hence affect the travel times. Because of complexity of travel times, this research did not use the estimated time built into the network and instead used the distance along the road network (metres) when calculating how far a student was from school. This network however, was built for calculating vehicle routes and journeys, and so only roads suitable for vehicle use were included in the network. Because students could walk or bike using pedestrian only routes, a shapefile of pedestrian pathways was obtained from the NZOGPS project and was added into the network. These pedestrian paths contained the length of the foot paths in metres but did not have the amount of time it took to travel down these paths. This was another reason the travel distance were used in this analysis instead of travel time. The road network also contained additional information such as road surface type and whether the street was one way. For the purpose of this analysis however, the one way streets were ignored due to students being able to walk or bike up these roads freely.

3.2 Data Processing

The student address points, school zones, and school points were all projected into the NZGD2000 New Zealand Transverse Mercator projection system to be combatable with the road network data set from the Geohealth lab which would be used for calculating the distances that students travel to school.

To determine the out-of-zone percentage for each school, first, student address points and school zones were split into multiple files based on the school they attended or belonged to. This was done for the ease of calculating school out-of-zone percentage, as zones overlapped and students being within a school's zone but attending a different school could've complicated the tools used to generate the statistics. Second, a spatial query on each school's zone was performed in ArcGIS© in order to derive the number and percentage of students attending each school that were within that school's zone. While a field in the roll return data did state whether the student was in-zone or out-of-zone, this field was filled in by the school and had some false positives and false negatives; where students had been coded as being in-zone when they were actually out-of-zone, and vice versa. Because of this inconsistency, each student's zoning status was recalculated using a spatial query to record whether the student was physically in-zone, out-of-zone, or zoning was not applicable for the school each student attended. One reason for this inconsistency is that if a student in the past has been enrolled and was in-zone, but in subsequent years has moved out of the zone, then for funding purposes they could be considered to still be in-zone. If this were the case, the student would potentially be in another school's zone, or be in closer proximity to a different school, and yet they have decided to remain at the school they previously attended. This is important to this thesis as it is using out-of-zone percentage as a proxy of school desirability, with a school attracting students from far away being seen as desirable. This choice may infer that school is preferable, or desirable, as if the school was of poor quality then the student would have shifted schools when they shifted dwellings. Because of this theory, the student's zoning status were recalculated using their physical location instead of the school's interpretation of their zoning status. The inconsistencies in the zoning status data could have been caused by either input error, or this phenomenon of students shifting. However, for the purpose of this research, the physical location of the student was prioritised over funding entitlement. The new zoning status field calculated was then used to produce the percentage of each schools roll that were out-of-zone.

While out-of-zone percentage is being used as a proxy to indicate a schools desirability, parents can also specifically move residence in order to be within zone of a desirable school, hence the proportion of all secondary students that live within a school's zone that go to that school could also indicate if the school is desirable. The proportion of potential students within the zone going to the school is referred to as market share. The market share of each school was calculated by taking the schools roll physically within the zone and dividing it by the total possible students within the schools zone. This measure is assumed to indicate the desirability of each school. If a student is within zone but goes to a different school then the assumption is the other school must be perceived to be better or more suitable. For this measure, a state student market share was calculated to compare the schools in a uniform manner, as private and state integrated schools can cater to a different set of values and have different financial responsibilities than a state-funded school.

Of the 28,337 student records, 701 (2.5%) did not have address points associated with them. These non-geocoded records may have been due to the record having no street number, the address not existing, the student being a boarding student, the student address being flagged as private due their parent having a sensitive occupation, or flagged as private due to care and protection issues. Geocoding is where a list of addresses are cross-referenced with a database which has the spatial information of each address built into it. If an address in the list is an exact match to an address in the database then a point is plotted on the address, with all of the information associated with the record in the list being attributed to the point. Under the roll return data scheme, the school is required to obtain the original address of the student, which is the legal guardian's place of residence if the student is boarding. If the dwelling they are boarding at is listed as the address then it is seen as an invalid address and the point is excluded from the geocoded roll return data. The address is excluded as the original purpose of roll return data is to see where students are coming from for zoning and information purposes. These purposes can include seeing which countries international students come from, and ensuring the students have the correct zoning status, in case they stay at a temporary residence to try and qualify for in-zone status. The record of the student however is still kept within the roll return data, and so for this research the 701 student records who did not have a physical address associated with them were excluded when calculating the out-of-zone percentage and market share for each school, as well as when allocating each student to their closest school.

The ERO report dates were obtained for each school in Greater Christchurch from 2004 to the present, and the difference between each report was calculated in months. The time difference between these reports was then averaged to give the average amount of time difference each school had between ERO reports. Using previous ERO reports, it is assumed that the longer the time between reports, the less help and oversight a school required, while a school with little time between reports may be evaluated more often to ensure steps to promote positive learning outcomes have been implemented, or what results previous steps have made.

3.3 Linear Regression Analysis

Linear Regression was run, using R, between the explanatory variables of ERO report time difference, school decile rating, school roll size, school market share, school leaver's rate, and school achievement, and the dependent variable: school out-of-zone percentage. R is an open source code based language and environment for statistical computing and graphics (R Core Team, 2015). The null hypothesis for the correlation analysis was that school decile rating, roll size, market share, ERO report, school leaver's rate, and school achievement would have no influence on the out-of-zone percentage. The alternative hypothesis is that the school characteristics mentioned above will have an influence on the out-of-zone percentage, specifically that:

- ERO report time difference will positively correlate with a school's out-of-zone percentage
- decile rating will positively correlate with out-of-zone percentage
- roll size will positively correlate with out-of-zone percentage
- school market share will positively correlate with out-of-zone percentage
- school leaver's rate will negatively correlate with out-of-zone percentage
- NCEA school achievement rate will positively correlate with out-of-zone percentage

If the school was desirable a high number of students would be expected to come from out-of-zone, but a high proportion of students from within the zone would also show that the school is desirable. Because of this assumption, market share was tested for correlation as an independent variable against the NCEA achievement rates, school leaver's rate, decile rating and roll size. If out-of-zone percentage correlated with the market share then this could point to potentially co-linearity between the market share and out-of-zone percentage, which will be discussed if a correlation is found between these two measures.

When calculating the out-of-zone percentages, Avonside Girls' High School (AGHS) and Shirley Boys' High School (SBHS) showed a high percentage of their students coming from outside of zone (~85%). On closer inspection, many AGHS and SBHS students were coming from just outside of their zone, which may have been influenced by portions of their zones being within the residential areas made uninhabitable by the earthquakes; known as the red zone. The inability of people to live in the red zone has seen many people shift to other parts of the city, and this could explain why these two schools have a large number of students coming from outside of their zone (a map of the red zone being shown in Figure 2). These two schools however, are moving campuses to the QEII park in the Parklands region in 2019, which is in closer proximity to where many of their students reside. Because of the anomaly created by the earthquake population shift, AGHS and SBHS have been excluded from the school regression analysis for out-of-zone percentage. The market share calculations however, accounted for the population shift and hence remained in the market share correlation analysis. This is because the market share is calculated by dividing the total number of students within the zone by the students who attended the school whose zone they are within, which already takes into account the population displaced by the red zone. Because of this effect AGHS and SBHS remain in market share correlation analysis. The school achievement rate and school leaver's rate were not tested for co-linearity as the school leaver's rate was a variable to account for the possibility of students not attempting, or not being enrolled in NCEA and hence being omitted from achievement statistics. Together these measures attempted to paint a clearer picture of the school's academic performance.

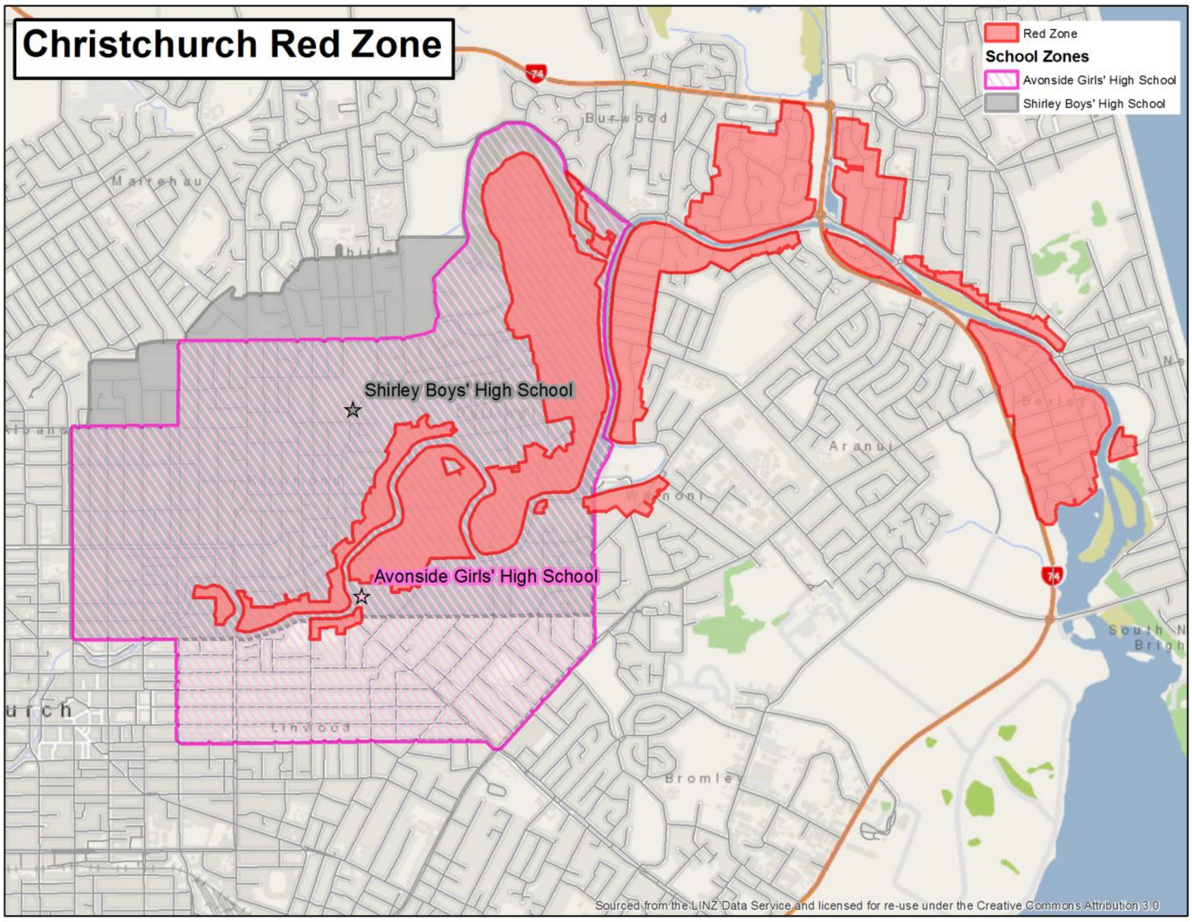

Figure 2: East Christchurch Red zone map

When calculating the school out-of-zone percentages it was noticed that many of the schools within Christchurch did not have enrolment schemes. Of the 19 state secondary schools only 11 schools had schemes (including AGHS and SBHS). It was also noted that of the schools with enrolment schemes the lowest decile was 5. Because of the enrolment scheme bias which excluded low decile schools, the decile rating was also tested for correlation with school achievement rate, roll size, ERO report difference, and school leaver's rate. This linear regression would give insight into the claims that parents use decile rating as an indicator of school quality (Hill, 2016; Moir, 2016)

Having the student address points allowed an out-of-zone percentage to be calculated for each meshblock, which could then be compared for ethnicity, income, and deprivation score without compromising individual privacy. This was done by joining the attribute information of the meshblock to each student record and then aggregating the student points based on their zoning status. The outcome was then used to calculate the percentage of students who went out-of-zone for school per meshblock. The out-of-zone percentages per meshblock were calculated using the state school students, excluding the state integrated and private students. This was done as the majority of private and state integrated schools did not have zones, which could unduly bias the proportions of zoning status of each meshblock, as well as the confounding effect that private boarding students could have on this proportion. State students who went to a school without a zone were still included when calculating the percentage however, as these schools made up a substantial proportion of lower decile schools, and being state schools still allowed parental choice to play a part in their school selection. This data was then joined with the 2013 census data pertaining to median income and deprivation score of each meshblock. With this information linear regression was run to reveal whether income, deprivation, or ethnicity (percent NZ European, and percent Maori) significantly correlated with out-of-zone percentage. NZ European and Maori were compared against the out-of-zone percentage per meshblock because of previous research into the disparity between Maori social, political, and academic status compared to NZ Europeans (Marie, Fergusson & Boden, 2008)

3.4 Travel Distance Analysis

3.4.1 Data description and data exclusions

Once the linear regression identifies which school characteristics make a school seem desirable, it is important to quantify the impact on transport that school desirability can have. Schools being bypassed in favour of a more desirable school would result in students travelling further distances to get to school. Increase in distance may result in more traffic being on the roads during school drop off and pick up times, which can have an environmental and social impact. This research seeks to quantify the impact by showing the distance saved if each student went to their closest school.

To calculate the distance that would be saved if every student went to their local school, first the distance each student travelled to the school they were enrolled in for, March 2015, was calculated. An OD Cost Matrix was run in ArcMAP 10.3©, using the students who went to the school as the origin, and the school that they went to as the destination. This matrix produced the shortest network distance route in metres that each student could possibly take to their school using the road network analysis dataset to calculate these distances.

When running the March 2015 OD Cost Matrix, boarding students and students with a FTE score lower than 0.8 were excluded from the analysis. Boarding students were excluded as the address recorded is their caregiver's address and not their physical location over the term. FTE represents the number of days a student attends school in a week, with 1.0 being five days a week, 0.8 being four days a week, and 0.2 being one day a week. When investigating the student address points, some students were noticed to be coming from as far away as Invercargill and Nelson. On closer inspection of these points, they were not boarders but it was noticed that their FTE score was lower than 0.4. It was possible that these could have been adult students, but because the student's date of birth were not available within the dataset it was not possible to clarify. Lower than 0.8 FTE students were hence excluded, as a way of excluding the adult students (aged 21 and over) who may only attend a few days a week, potentially at night, and would travel further due to the limited schools that offer adult courses. An FTE score of 0.8 was deemed as an acceptable cut off mark as a student travelling four days a week would still contribute to the long term traffic congestion and other consequences of travelling to school, while students fewer than four days a week would have less of an impact. Two schools Emmanuel Christian School and Hillview Christian School and their students were also removed from the analysis due to the schools only going up to Year 10, as it would be erroneous if students above Year 10 were assigned to those school.

The OD Cost Matrix calculated the travel distance along the network that each student travelled to school in March 2015. After the routes that each student travelled were calculated the routes were summarised based on the school each student attended; to show the sum, mean and median, travel distances for each school. This analysis of student distances could then be compared to the results after reallocating each student to their closest school, while still preserving individual student's privacy. The distances calculated for each student were one-way trips only, from their residence to their school, and did not account for the return trip.

3.4.2 Closest Facility Analysis

In order to compare the distances students currently travel to the distance they could travel if they went to their closest school, each student had to be allocated to their closest school. This was done by using the Network Analyst Closet facility tool within ArcGIS© to assign each student to their closest school based on the network distance along the road and pedestrian-only network. Multiple permutations of this reallocation were run, with varying school and student types being allocated together. These permutations varied with some using a combination of state, state integrated and private students (SIP), state integrated and state students (SI), or state students (S) to varying school types. A full list of the permutations are shown in Table 1. These permutations were done to account for the fundamental differences between private and state integrated schools compared with state schools. The difference between private/state integrated and state schools is that there are stricter entry criteria and more financial cost at private and state integrated schools. This means that not every person can attend the schools regardless if they are spatially close, and hence permutations were run removing the private and state integrated from the closest school analysis. The analysis was also further split into male and female due to the existence of single sex schools. After the males and females had been allocated to their closest gender appropriate school, the results were then combined into one table, summary statistics of the count of students, sum distance, and average distance were then calculated for each school. These summary statistics were then compared with the current school distance summary statistics. Another set of permutations were run where students were assigned to their closest school regardless of gender to highlight the differences that this would have on the closest school allocation.

As mentioned earlier Avonside Girls' High School and Shirley Boys' High School are planning to move from their current campus to a new site in Queen Elizabeth II Park in 2019. Because of this change, another permutation set of the closest facility analysis was run with the two schools in their new location. This was run to show how the campus movement could potentially change the student distribution for the network of schools based on closest distance. These permutations were then consolidated down to into four tables to allow easy comparison between similar permutations. These four tables were classed as Moved Gendered, Unmoved Gendered, Moved Ungendered, and Unmoved Ungendered. The permutations were consolidated based on whether AGHS and SBHS had been moved, and if single-sex schools only took the corresponding gender or if this was ignored. For the permutations where AGHS and SBHS had been moved, the distance the students of AGHS and SBHS travelled in 2015 was replaced by the distance they would travel if the sites were on their new Queen ELizabeth II park site. This was to ensure the current enrolment patterns could be compared to the patterns once the students had been reallocated to their closest school.

Table 1: Permutations of closest school reallocation

Permutations	Student Types	School Types
Unmoved Gendered		
	SIP	SIP
	SI	SI
	S	S
	SI	S
	SIP	S
Unmoved Ungendered		
	SIP	SIP
	SI	SI
	S	S
	SI	S
	SIP	S
Moved Gendered		
	SIP	SIP
	SI	SI
	S	S
	SI	S
	SIP	S
Moved Ungendered		
	SIP	SIP
	SI	SI
	S	S
	SI	S
	SIP	S

3.5 Zone Generation

Using the results from the closest facility analysis polygons were drawn around the students based on their closest school. This was done to visualise the allocation of students to their closest school without infringing on individual students privacy. Two sets of "zones" were generated, one using state secondary schools where single sex schools were only able to take the appropriate student (Gendered), and the other using state secondary schools where single sex schools were able to take all students (Ungendered). Both sets of zones were generated with Avonside Girls' High School and Shirley Boys' High School residing on their new campus in Queen Elizabeth II park due to the schools opening on the site in 2019 (Hume and Laurenson, 2016).

3.6 Carbon Analysis

To quantify the environmental impact of decreasing travel distances to school the distances calculated in the analysis were used to find the volume of carbon dioxide produced per kilometre travelled. Because not all students would travel by car, previous research was consulted to see at what distance students were more likely to be driven to school. Black, Collins, and Snell (2001) found that approximately 50% of primary aged students were driven to school if they lived over 2km away. While Black et al's. (2001) study investigated primary aged students, for the sake of calculating potential carbon emission savings, this benchmark of 2km was still used to show how much potential carbon could be saved. In this calculation it was assumed that if a student is more than 2Km away then they would travel by car.

Using this benchmark, the state students who currently travelled more than 2Km were extracted out, and the sum distance travelled by these students per trip was utilised in a carbon equation to calculate the volume of pollution produced by cars travelling that distance. The carbon equation used in this research was an equation utilised by the NZ Ministry of Transport (2014) to calculate the emissions of its fleet of cars; this equation being CO_2 grams/per Km = 22.961 x petrol consumption (L/100km). The fuel efficiency standard outlined by the U.S Department of Transportation for passenger automobiles back in 1985 was 10.4 L/100km (Goldberg, 1998) with the standards in 2009 requiring a petrol consumption of 6.1L/100km (Shiau, Michalek, and Hendrickson, 2009). Using these standards, a petrol consumption of 8L/100km was derived to use as an average fuel consumption to calculate the total amount of $C0_2$ in grams that would be saved if each student went to their closest school. The carbon calculation was only carried out on the current state school students and on the State to State Moved Gendered permutation, due to the unlikelihood that state integrated and private students could be reallocated, and AGHS and SBHS moving sites in early 2019 making this permutation from the Moved Gendered permutation set the most relevant scenario.

3.7 Optimal School Location analysis

Because of the hypothetical scenario of reallocating the students to their closest school, the analysis was taken one step further to show the absolute minimum amount of distance that students could possibly travel to school, by moving the schools to the students. Finding the optimal locations was calculated by using ArcGIS© Location-Allocation Tool, specifying that it needed to find 18 locations that minimised the distance between all the state student points. There are 19 state schools in the region, but because AGHS and SBHS are essentially one school being on the same campus, only 18 possible locations were selected for the analysis. The analysis required the potential sites to be defined. Initially address points for Greater Christchurch from the Land Information New Zealand (LINZ) Street Address Electoral dataset were used as potential sites for the schools, equating to 224,583 address points. However ArcGIS© was unable to process this number of address points. The road intersections derived from the NZOGPS road network dataset were then tried as potential school sites, but the 17,910 points required to cover Greater Christchurch was again too large for ArcGIS© to process. To reduce the number of potential sites further, the road intersections dataset was converted into a Raster layer so that the centroids of each cell could be used as a potential location. Various cell resolutions were tested and finally the Location-Allocation tool successfully ran using centroids from a 300 metre grid, equating to 4,654 possible locations.

4. Results

The following chapter will seek to answer the research questions posed in the Introduction (Section 1.3 Aims and Objectives).

1) Which school characteristics, specifically NCEA achievement rates, ERO report time difference, school leaver's rate, decile rating, market share, and roll size correlate with a school's out-of-zone percentage?

2) Which neighbourhood effects, specifically deprivation score, income, or ethnicity, correlate with an area's out-of-zone percentage?

3) What distance of travel could be saved if all secondary students went to their closest school, or if school locations were shifted to optimise travel distance for all students?

4.1 School characteristic regression

4.1.1 Out-of-zone percentage regression

After the anomalies of AGHS and SBHS were removed from the out-of-zone percentage analysis the linear regression did show significant correlation between some of the predictor variables and the dependent variable; out-of-zone percentage (Table 2). The percentage of school leavers that left before their 17th birthday showed the highest correlation with the out-of-zone percentage, indicating a negative relationship, in that a school with a low percentage of out-of-zone students would have a high percentage of students leaving before their 17th birthday; a proxy for school dropout. The relationship between the percentage of students left before 17th birthday and out-of-zone percentage was significant ($p = 0.001$), with a strong association ($r^2 = 0.707$).

The academic achievement rates of each school did not correlate consistently over either NCEA level or level of achievement. For example, the NCEA level 1 & 2 not achieved percentage was not significant, while the NCEA level 3 not achieved percentage had a significant correlation and a strong association ($r^2 = 0.577$) with out-of-zone percentage. As seen in Table 2, many of the achievement rates however were close to the significance level of 0.05, with NCEA level 1 achieved, level 2 not achieved and excellence, and level 3 excellence all having a p-value below 0.13. The results did however, find that the NCEA Level 1, 2, and 3 Merit rates all correlated with out-of-zone percentage, showing that a school with a high percentage of out-of-zone students was expected to have a high proportion of it's students attaining Merit in NCEA at all levels. The regression coefficient between all the achievement rates and the out-of-zone percentage, though some being not significant, followed a pattern of schools with a low percentage of out-of-zone students also had a high percentage of not achieved and achieved, while having a lower percentage of merit and excellence. Conversely the schools with a high number of out-of-zone students had lower percentages of not achieved and achieved and a higher percentage of merit and excellence (Table 2). The out-of-zone percentage did not significantly correlate with the Market Share, with a p-value of 0.651 and an r^2 of 0.024.

The significant results of NCEA Level 1, 2, and 3 merit rates and the left before 17th birthday percentage were tested for co linearity by running multivariable regression with the out-of-zone percentage against these measures with decile rating as a factor. Of the merit rates tested only the decile 9 of NCEA Level 3 came back with a significant result (p= 0.048), with none of the other deciles ratings as factors between the out-of-zone percentage and merit rates reaching significance. The left before 17th birthday percent tested this way had none of the decile ratings reach significance, suggesting no co-linearity with the decile rating (Appendix 1).

Table 2: Regression between school out-of-zone percentage and school characteristics

Independent Variable	Coefficient	R^2	CI 2.5 - 97.5	p value
NCEA Lv1 Not Achieved %	- 1.180	0.12	-3.59 — 1.23	0.297
NCEA Lv1 Achieved %	- 0.852	0.352	-1.72 — 0.02	0.054
NCEA Lv1 Merit %	**1.544**	**0.638**	**0.67 — 2.42**	**0.003**
NCEA Lv1 Excellence %	0.887	0.091	-1.23 — 3.00	0.368
NCEA Lv2 Not Achieved %	- 2.860	0.269	-6.41 — 0.69	0.102
NCEA Lv2 Achieved %	**- 1.225**	**0.524**	**-2.10 — -0.35**	**0.012**
NCEA Lv2 Merit %	**1.604**	**0.608**	**0.63 — 2.58**	**0.005**
NCEA Lv2 Excellence %	2.165	0.311	-0.27 — 4.60	0.075
NCEA Lv3 Not Achieved %	**- 1.980**	**0.577**	**-3.26 — -0.70**	**0.007**
NCEA Lv3 Achieved %	- 0.800	0.084	-2.79 — 1.19	0.386
NCEA Lv3 Merit %	**1.391**	**0.407**	**0.12 — 2.66**	**0.035**
NCEA Lv3 Excellence %	2.253	0.236	-0.80 — 5.31	0.129
Roll size	0.008	0.077	-0.01 — 0.03	0.407
Left Before 17th Birthday	**- 1.955**	**0.707**	**-2.90 — -1.01**	**0.001**
Total Market Share	- 0.216	0.024	-1.26 — 0.83	0.651
ERO Average Difference	0.411	0.016	-2.02 — 2.84	0.711

Dependent Variable: out-of-zone percentage. **Significant values in bold**

Table 3: Regression between school out-of-zone percentage and decile rating

Decile Rating	Coefficient	CI 2.5-97.5	P value
5	1	-	-
6	16.041	-29.20 — 61.28	0.42
7	34.373	-10.87 — 79.62	0.11
8	13.925	-21.12 — 48.97	0.37
9	**44.904**	**7.96 — 81.84**	**0.025**

Dependent variable: out-of-zone percentage. **Significant values in bold**

4.1.2 Decile Rating Regression

Because decile rating is an ordinal variable, for the regression carried out between decile rating and the out-of-zone percentage it was analysed using decile rating as a factor, with the correlation run to test whether each decile rating was significantly different to the lowest decile score; five in this case. As shown in Table 3 only the decile nine schools showed a significant correlation with out-of-zone percentage (p = 0.025) compared to the decile 5 schools used as the reference variable. Of the schools in Christchurch with enrolment schemes the lowest decile rating among them was 5. Hence, regression was carried out between all the school's decile rating and each school's achievement rates, ERO report difference, and the left before 17^{th} birthday rate in the Greater Christchurch region. This regression analysed all schools in the region, not just those who had an enrolment scheme, and so out-of-zone percentage and market share could not be included in this regression. For this decile rating regression on all the schools the decile ratings were again considered as an ordinal variable, however, to make the results more efficient the decile ratings were split into bins of low decile, medium decile, and high decile. Because there were nine deciles represented by the schools (2 to 10) the low decile school bin was defined as schools with decile ratings of 2,3, or 4, medium decile bin has decile ratings of 5, 6, or 7, and high decile bin had schools with decile ratings of 8, 9, or 10. Of the 26 schools used in all schools decile regression analysis five schools were in the low decile bin, 8 in the medium decile bin, and 13 in the high decile bin.

Using the low decile school bin as the reference variable the medium decile schools did not significantly differ from the low decile schools when it came to all of the achievement rates, with the p-values ranging from 0.14 to 0.95 (Refer to Appendix 2). Most of the high decile schools conversely significantly correlated compared to the low decile bin, with NCEA Level 1 and Level 3 not achieved being the only achievement rates which did not significantly correlate with the decile rating. The merit and excellence coefficients for the high decile bin were positive while the not achieved and achieved coefficients were negative.

The medium and high decile bins significantly correlated compared to the low decile bin reference variable with both the left before 17th birthday rate (p = 0.008, p= <0.001) and ERO report time difference (p = 0.001, p = 0.02). The left before 17th birthday rate negatively correlated with the decile rating with the medium decile bin showing a 13.37 percent decrease in students leaving before their 17th birthday compared to the low decile bin, while the high decile schools showed a 22.41 percent decrease than the low decile schools (Table 4). The ERO report time difference positively correlated with the decile rating, with the medium decile schools showing a 13.77 greater month difference between reports than the low decile schools, while the higher decile schools saw a 8.8 greater month difference between reports (Table 5).

Table 4: Regression between school leavers rate and Decile groupings

Decile grouping (SES)	Coefficient	CI 2.5-97.5	P value
1 (Low SES)	1	-	-
2	**-13.367**	**-22.90 — -3.84**	**0.008**
3 (High SES)	**-22.411**	**-31.21 — -13.61**	**<0.001**

Dependent variable: left before 17th rate. **Significant values in bold**

Table 5: Rregression between ERO report time difference and Decile groupings

Bin	Coefficient	CI 2.5-97.5	P value
1	1	-	-
2	**13.767**	**5.90 — 21.63**	**0.001**
3	**8.805**	**1.55 — 16.06**	**0.02**

Dependent variable: ERO report time difference (months). **Significant values in bold**

4.1.3 Market Share regression

Of the variables tested against market share, school decile rating was the only variable which reached significance, with only the decile 8 and 9 schools significantly differing from the reference decile 5 schools (Table 6 and Table 7).Compared to the reference variable the decile 8 and 9 schools showed a positive correlation with the market share. The decile 8 schools having a 31.78% increase in market share compared to the decile 5 schools, while the decile 9 schools had a 27.69% increase compared to the decile 5 schools (Table 7). Table 6 below shows the other correlation results for market share, with low r^2 values and high p-values showing no significant correlation between the school market share and the achievement ratings, ERO report difference, or left before 17th birthday rate.

Table 6: Regression between school market share and school characteristics

Independent Variable	Coefficient	R^2	CI 2.5-97.5	p value
NCEA Lv1 Not Achieved %	-1.504	0.294	-3.05 — 0.04	0.055
NCEA Lv1 Achieved %	- 0.114	0.009	-0.92 — 0.69	0.761
NCEA Lv1 Merit %	0.212	0.017	-0.86 — 1.29	0.673
NCEA Lv1 Excellence %	1 .057	0.204	-0.33 — 2.44	0.121
NCEA Lv2 Not Achieved %	0.121	0.001	-2.9 — 3.14	0.931
NCEA Lv2 Achieved %	- 0.208	0.024	-1.1 — 0.68	0.617
NCEA Lv2 Merit %	-0.003	0	-1.13 — 1.12	0.995
NCEA Lv2 Excellence %	1.073	0.116	-0.89 — 3.04	0.255
NCEA Lv3 Not Achieved %	- 0.307	0.021	-1.71 — 1.09	0.639
NCEA Lv3 Achieved %	- 0.694	0.116	-1.96 — 0.58	0.254
NCEA Lv3 Merit %	0.310	0.033	-0.8 — 1.42	0.551
NCEA Lv3 Excellence %	1.684	0.215	-0.45 — 3.82	0.111
Roll size	0.003	0.011	-0.01 — 0.02	0.735
Left Before 17th Birthday	- 0.704	0.132	-1.9 — 0.49	0.222
ERO Average Difference	- 1.215	0.189	-2.67 — 0.42	0.137

Dependent variable: Market share. **Significant values in bold.**

Table 7: Regression between school Market share and decile rating

Decile Rating	Coefficient	CI 2.5-97.5	P value
5	1	-	-
6	3.849	-17.4 - 25.1	0.69
7	10.165	-15.86 - 36.19	0.39
8	**31.780**	**11.62 - 51.94**	**0.006**
9	**27.693**	**6.45 - 48.94**	**0.017**

Dependent variable: School market share. **Significant values in bold**

4.2 Neighbourhood effect regression

The meshblock analysis tested the independent variable for correlation with the predictor variables of meshblock deprivation score, meshblock median 2013 income, percent of state secondary students of NZ European decent, and percent state secondary students of Maori decent within each meshblock. The independent variable being state secondary out-of-zone percentage per meshblock. The results, shown in Table 8, found that while all the predictor variables were significant, all the relationships had weak associations with meshblock out-of-zone percentage (r^2 <= 0.01).

Table 8: Regression between Meshblock out-of-zone percentage and predictor variables

Independent Variable	Coefficient	R^2	CI 2.5-97.5	p value
NZ Deprivation Score	**-0.052**	**0.01**	**-0.07 — -0.04**	**<0.001**
2013 Median Income	**0.000**	**0.01**	**$9.50e^{-5}$ — $1.85e^{-4}$**	**<0.001**
Percent NZ European	**0.041**	**0.001**	**0.003 — 0.08**	**0.03**
Percent Maori	**0.069**	**0.001**	**0.02 — 0.12**	**0.009**

Dependent variable: Meshblock out-of-zone percentage. **Significant values in bold**

4.3 Transport Analysis Results

The transport analysis results have been summarised under each of the permutations sets, with the roll differences, sum distance, average distance, and median distance being displayed for each permutation set. The Unmoved Ungendered permutations were not included in the result section as AGHS and SBHS moving would make the allocation of students to current sites irrelevant after 2019, also any information of interest would be present in the Unmoved Gendered and Moved Ungendered Permutation sets. A full list of the transport distance results for all the permutations and permutation sets can be found in Appendix 3, 4, 5, and 6.

4.3.1 Moved Gendered permutation set transport results

This set of permutations moved Avonside Girls' High School and Shirley Boys' High School to their new site, and took into account whether the school was single sex and assigned the correct gender to the single sex schools.

School roll differences

When reallocating state school students to their closest state school, schools experienced an increase in their rolls, while others experienced a decrease. As shown in Figure 3 there were four schools which were allocated over 2.5 times (a 150% increase) what they currently had enrolled in their school in 2015; Aranui High, Hornby High, Linwood College, and Mairehau High Schools. The other schools either experienced a relatively small gain; as was the case for Papanui High, Rangiora High, Hillmorton High, and Kaiapoi High Schools, or a decrease in the number of students allocated to them compared to what they had in 2015. Hagley Community College, Christchurch Boy's, and Christchurch Girls' High School would see the largest decrease in roll numbers in this permutation, a reduction of more than 50% of their March 2015 rolls. This decrease in some schools and large increases in others suggests that currently even though some students are closer to certain schools they are bypassing them in favour of other schools

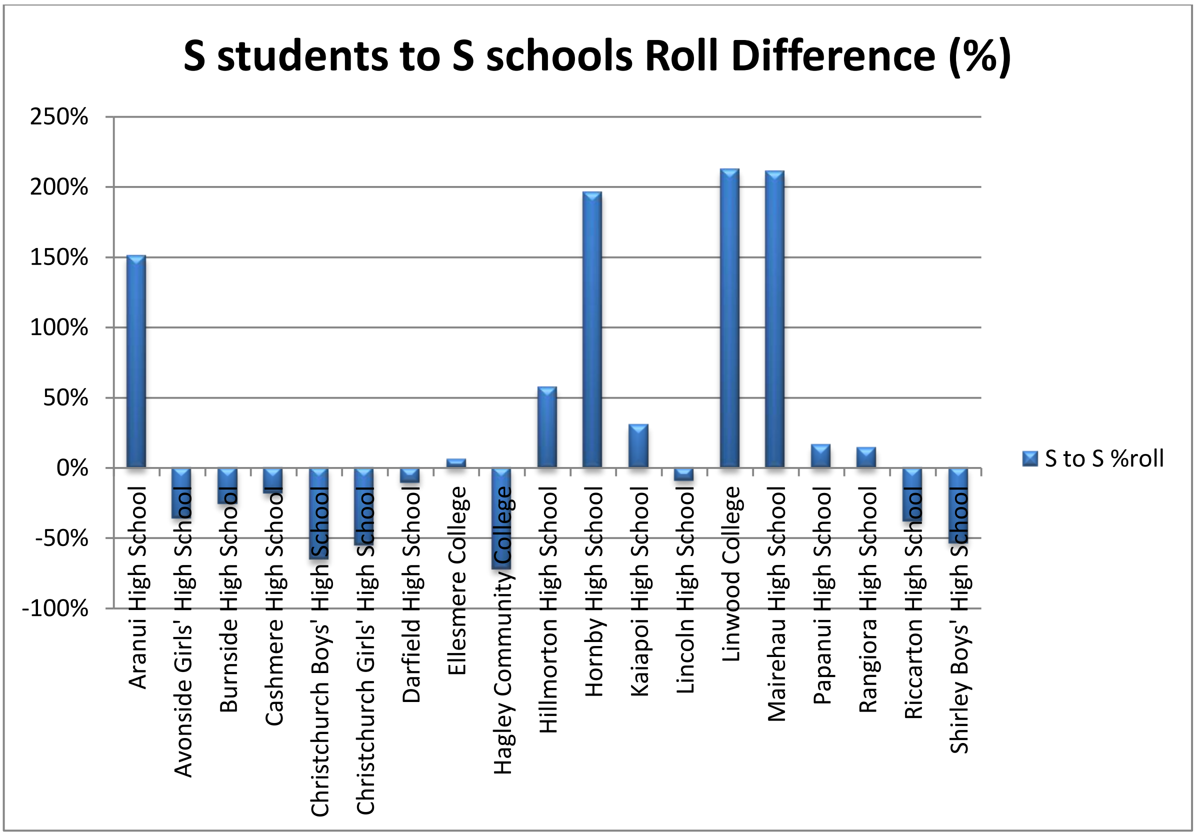

Figure 3: Roll percent differences for state schools when closest state student reallocated to them; using the Moved Gendered permutation set

If all the students attending any state, state integrated, or private schools where allocated to their closest school regardless of entry criteria (except gender), similar to the state student to school allocation, some schools would see their rolls increase. The schools that would see a substantial increases in their roll numbers were Aranui High School, Hornby High School, Linwood College, Mairehau High School, Christchurch Adventist School, and Hillmorton High School as shown in Figure 4. Aranui High, Hornby High, Linwood College, and Mairehau High Schools are the same as the state to state variation roll changes, while Christchurch Adventist and Hillmorton High School are state integrated schools. It is worth noting however that Christchurch Adventist School only had 90 students enrolled in March 2015.

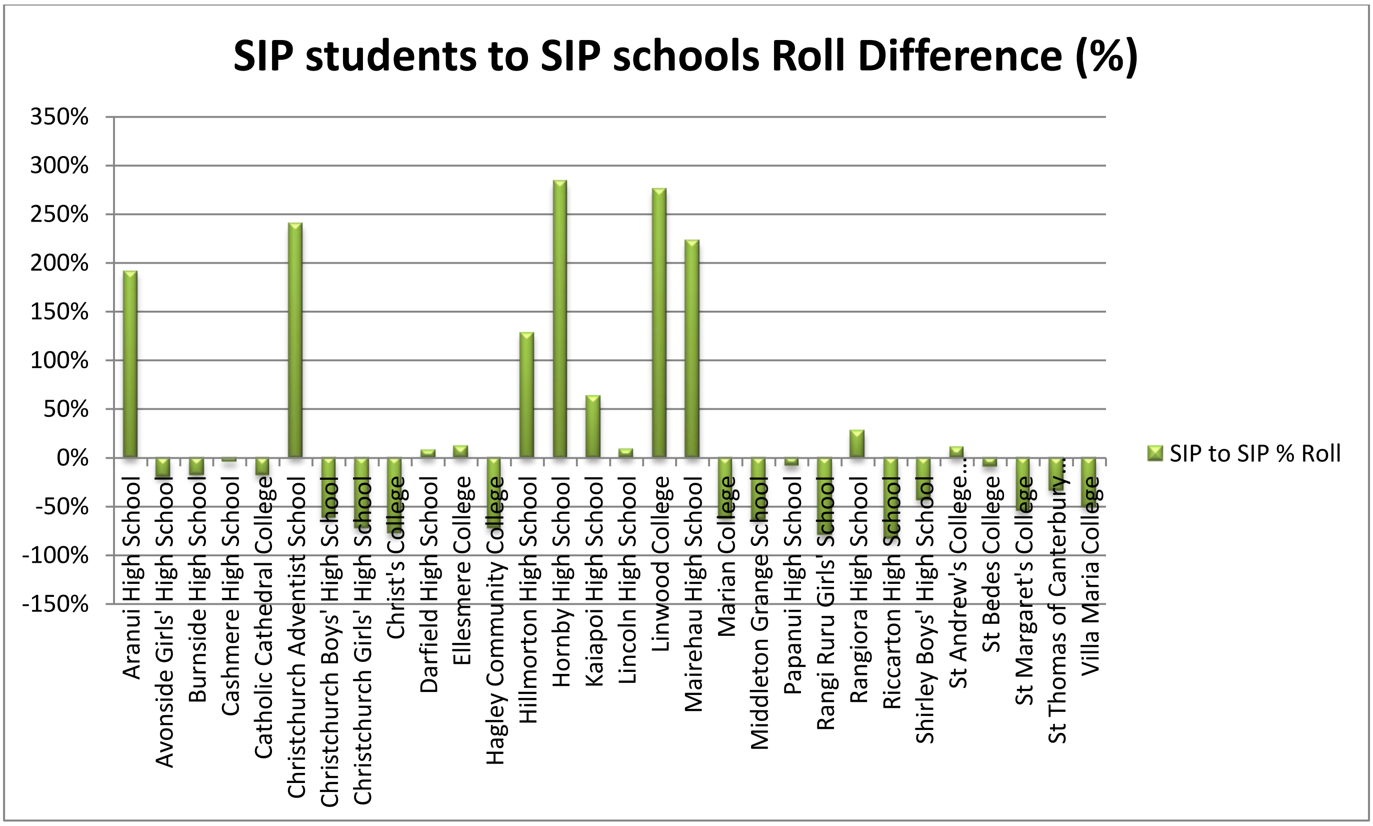

Figure 4: Roll percent differences for state, state integrated, and private (SIP) schools when closest SIP students reallocated to them; using the Moved Gendered permutation set

<u>Sum distance reduction</u>

The state school students travelling to the school they were enrolled in travelled a sum distance of 119,706.67 kilometres (km) per trip, while assigning each student to their closest school resulted in a sum distance of 80,195.8 km per trip, as seen in Table 9. Therefore for state students travelling to their closest gender appropriate school they travelled 39,510.9 km less per trip than if they went to the state school they were enrolled in. There are 2 trips made between the student's school and the student's residence each day; one going to school in the morning, and one coming back from school in the late afternoon.

For a combination of state, integrated, and private students travelling to the school they are currently enrolled in they travelled a sum distance of 171,984.3 km, while assigning each to their closest school would result in a sum distance of 100,497.4 km. For state, integrated, or private students travelling to their closest gender appropriate school they would save a total of 71,486.9 km.

Table 9: Moved Gendered Transport distance Permutations statistics

Permutation	Total Sum Distance	Total Average Distance	Total Median Distance	State Sum Distance	State Mean Distance	State Median Distance
Current	171,984.33	7.09	4.38	119,706.67	6.38	3.71
SIP to SIP	100,497.39	4.14	2.11	94,876.00	4.58	2.31
SI to SI	91,796.73	4.14	2.16	87,120.04	4.45	2.26
S to S	80,195.78	4.27	2.26	-	-	-
SI to S	93,590.43	4.22	2.29	-	-	-
SIP to S	103,418.01	4.27	2.31	-	-	-

<u>Average and Median distance saved</u>

State students travelling to their state school in March 2015 on average travelled 6.38 km to get to school, with the median being 3.71 km. When assigning them to their closest state school however, the average student would travel 4.27 km, while the median would be 2.26 km, as shown in Table 9.

State, state integrated, and private students travelling to their school in March 2015 on average travelled 7.09 km; 6.38 km if they are a state student, 9.34 km for state integrated, and 9.88 km for private school students (state integrated and private results found in Appendix 3). Assigning each student to their closest school however, would see the average state student travelling 4.58 km, integrated travelling 1.80 km, and private travelling 1.22 km; overall the average state, state integrated, and private student would travel 4.14 km. The difference in the average distance travelled currently and allocated to their closest school shows that state integrated and private school students travel further to go to school. Allocating each student to their closest school overall would see the average student travelling 3 km less to go to school.

Overall the median distance travelled by students in 2015 was 4.38 km, with the median distance state student travelled being 3.71 km, state integrated travelled 6.92 km, and private travelled 6.51 km. Comparing the 2015 distances to the closest school for each category the state integrated and private students are still travelling further to get to school than their state school counterparts. If each student was assigned to their closest school then overall the median distance travelled would be 2.11 km, median state would travel 2.31 km, state integrated students would travel 1.64 km, and private school students would travel 1.22 km. Currently the average private and state integrated students travelled further to get to school, but when each student was allocated to their closest school the state school students would on average travel further. This reversal suggests that currently state integrate and private school students travel further to school than state students.

Using the SIP to S permutation, If all SIP students were allocated to their closest state school the average distance students would travel would be 4.27 km to school, compared to the 7.09 km they travelled in 2015. This equates to a reduction in distance of 2.82 km per student. This result is similar to the permutation where SIP students could also be allocated to private and state integrated schools (SIP to SIP); only travelling 0.13 km less if private and state integrated schools were excluded. This shows that if the private and integrated schools were removed and allocated to their closest state school, the distance saved per student would be almost identical to each student being assigned to their closest school. Because of the additional enrolment criteria of state integrated and private schools the rest of the reported statistics in the results section will focus on the state school reallocations, with the full tables of the SIP and SI permutation results available in Appendix 3, 4, 5, and 6.

4.3.2 Unmoved Gendered permutation set transport results

This set of permutations kept Avonside Girls' High School and Shirley Boys' High School on their existing respective campuses. This set of permutations is the same as the previous set with the gender of each school being taken into account, with the only difference being that AGHS and SBHS have not been moved.

School roll differences

For all state students allocated to their closest state school the same four schools Aranui High, Hornby High, Linwood College, and Mairehau High School saw large increases in their school rolls, however unlike the previous permutation set (see Figure 3) because of AGHS and SBHS not being in Queen Elizabeth II Park, Aranui High and Kaiapoi High School have had more students allocated to them. Aranui High having about four times as many students allocated to them relative to the roll they had in 2015 (Figure 5).

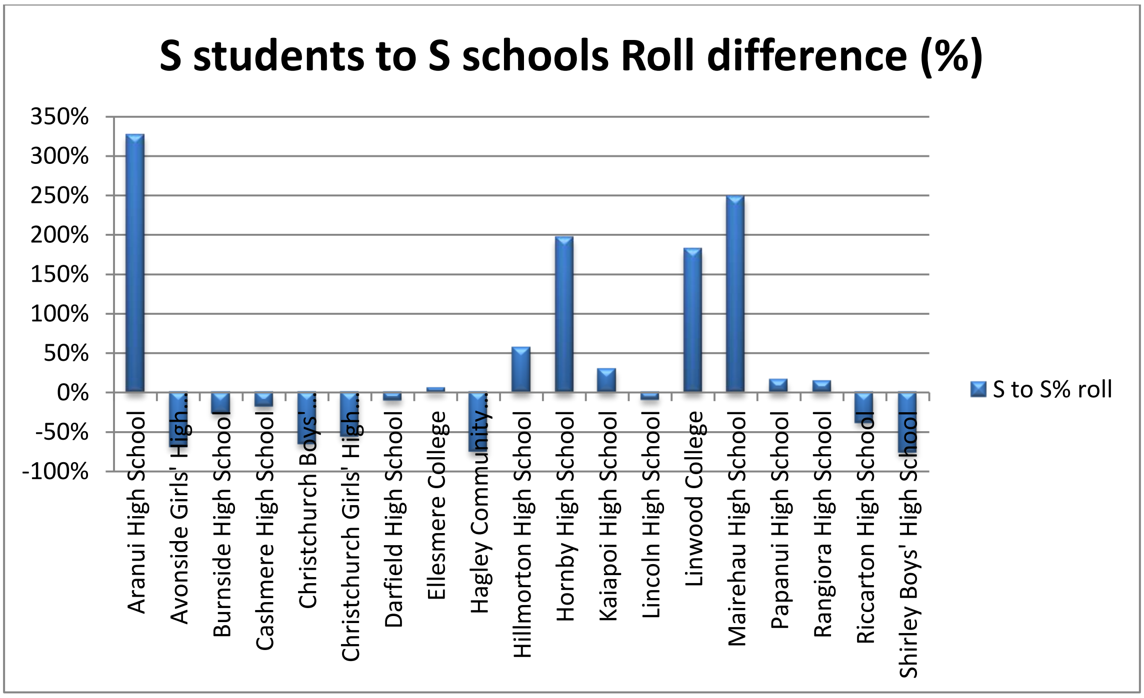

Figure 5: Roll percent differences for state schools when closest state student reallocated to them; using the Unmoved Gendered permutation set

<u>Sum distance saved</u>

In comparing the distances that AGHS and SBHS students travelled to their current site and their new site, their new site resulted in the AGHS students cumulatively travelling an extra 352 km, and the SBHS students travelling 560 km further in total. This resulted in the average SBHS student travelling 470 metres further, and the average AGHS student travelling 405 metres further than at their current sites (Appendix 4).

When allocating each state student to their closest state school there would still be an overall sum saving of 36,725.49 km in comparison to the current enrolment patterns (Table 10). The sum distance of 82,068.86 km when allocating each student to their closest school without moving AGHS and SBHS (Table 9), is greater than the 80,195.8 km sum distance when allocating students to their closest school when AGHS and SBHS are moved to their new campus (Table 10). So while current AGHS and SBHS students would travel further, overall students would travel less distance to get to school if SBHS and AGHS were located on their new site.

<u>Average and Median distance saved</u>

Allocating each state student to their closest state school without moving AGHS or SBHS would result in an average decrease in travel distance of 1.96 km compared to their March 2015 school, with the median decreasing by 1.36 km (Table 10).

Table 10: Unmoved Gendered Transport distance permutation statistics

Permutation	Total Sum Distance	Total Average Distance	Total Median Distance	State Sum Distance	State Mean Distance	State Median Distance
Current	171,072.01	7.06	4.32	118,794.35	6.33	3.66
SIP to SIP	102,890.00	4.24	2.15	97,529.83	4.68	2.41
SI to SI	94,089.96	4.24	2.20	89,730.85	4.55	2.35
S to S	82,068.86	4.37	2.30	-	-	-
SI to S	95,801.79	4.32	2.34	-	-	-
SIP to S	105,715.79	4.36	2.36	-	-	-

4.3.3 Moved Ungendered permutation set transportation results

The moved ungendered set of permutations had AGHS and SBHS moved to their new location in Queen Elizabeth II Park, but unlike the previous permutations this analysis disregarded gender for schools; meaning that boys could be allocated to girls only schools if that school was the closest. With AGHS and SBHS effectively becoming one school in 2019 as they will be sharing a campus, the purpose of this set of permutations was to show travel that could be saved if all schools were coeducational.

School roll differences

Similar to previous permutations with the state students to state schools, Aranui High, Hornby High, Linwood College, and Mairehau High School all would see increases between 150% to 200% to their rolls if all the closest students attended those schools, regardless of school gender (Figure 6). Other schools however, would see a decrease with CBHS and CGHS having almost half their roll allocated to a different school. AGHS in this permutation had all of their roll allocated to other schools as it is essentially on the same site as SBHS. This happened because the point for SBHS was manually moved when running these permutation sets, and happened to be placed a little closer to the road than AGHS, hence ArcGIS© allocated none of the students to AGHS instead giving any student in close proximity to SBHS. Because of these circumstances, in this case SBHS and AGHS can be considered as one school.

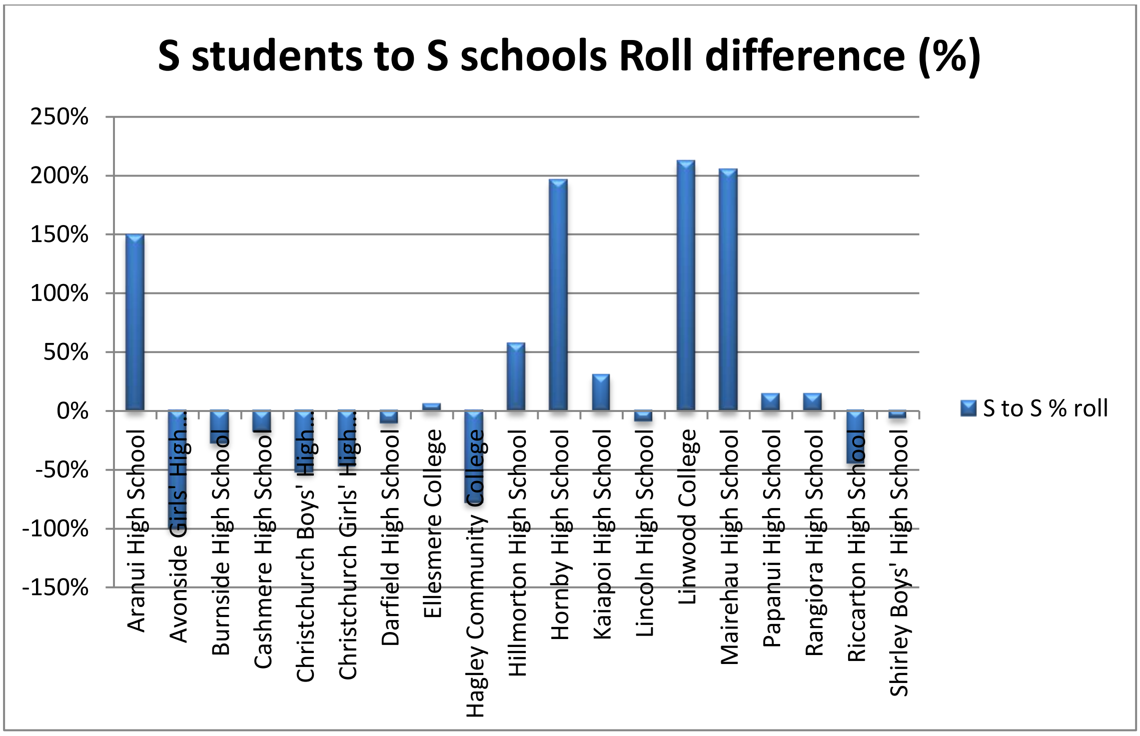

Figure 6: Roll percent differences for state schools when closest state student reallocated to them; using the Moved Ungendered permutation set

<u>Sum distance saved</u>

In the moved ungendered permutation set, the distance that current state students travelled to school was 119,706 Km, and the sum distance state students would travel to their closest ungendered school would be 79,834 Km (Table 11). Therefore ff each state student was allocated to their closest ungendered school they would save a total of 39,872 Km in travel distance.

<u>Average and Median distance saved</u>

Currently the average state school student travels 6.38 km to get to school, while if each student was assigned to their closest ungendered school then the average student would travel 4.25 km. Therefore if each student went to their closest school, if it was ungendered, each student would travel 2.13 km less than if they went to their currently enrolled school. The median distance state student travel in comparison was 3.71 km while the median distance closest state students, disregarding gender, would travel would be 2.22 km, a saving of 1.49 Km.

Table 11: Moved Ungendered Transport distance permutation statistics

Permutation	Total Sum Distance	Total Mean Distance	Total Median Distance	State Sum Distance	State Mean Distance	State Median Distance
Current	171984.33	7.09	4.38	119706.67	6.38	3.71
SIP to SIP	97409.47	4.02	2.06	90117.82	4.52	2.25
SI to SI	92383.12	4.16	2.10	86298.37	4.55	2.21
S to S	79834.81	4.25	2.22	-	-	-
SI to S	93177.33	4.20	2.26	-	-	-
SIP to S	102844.85	4.24	2.27	-	-	-

4.4 Carbon Emission Estimates

Of the current state school students 13,647 of the total 18,768 travelled further than 2km, equating to a sum of 112,087.67km travelled to their respective schools. Of the State school students in the Moved Gendered permutation, 10,767 of the total 18,768 travelled greater than 2Km to school, equating to a total of 69,456.03km.

Carbon emission estimates were applied to the distances:

Current State CO_2 grams = 112,087.67(22.961 x (8/100)) = 205,891.6g

Allocated State CO_2 grams = 69,456.03(22.961 x (8/100)) = 127,582.4g

The carbon equations calculated that if each state student was allocated to their closest state school it would result in an approximate 78,309.2 gram (78.3kg) reduction per trip of CO_2 produced due to transport. This would result in a 156.6 kg reduction in CO_2 per day.

4.5 Optimal school locations

Table 12: Optimal School Location transport statistics

Sum distance	Average distance	Median Distance
60,609.48	3.23	2.14

Moving the locations of the schools in order to calculate the minimum possible distance that all the state students could possibly travel found that, in total, the all students would travel a total of 60,609.48 km per trip, equating to an average of 3.22 km per student (Table 12). This is in comparison to the sum total of 119,706.7km and average of 6.4km that the students currently travel, and the 81,353km or 4.3km average when all the students were allocated to their closest school (using the Moved Gendered Permutation set). Applying the same method for estimating the carbon estimate, of the 18,768 state students, 10,208 of the students were greater than two 2km away from their closest optimal school site, resulting in a total distance of 49,610.65km. Applying this into the carbon emission equation estimates that 91,128.8g (91.1kg) of CO_2 would be produced per trip due to school transport if the schools were moved to minimise the distance between students, and each student was then allocated to their closest school. A map showing the optimal school locations in comparison to the current school locations is shown below in Figure 7.

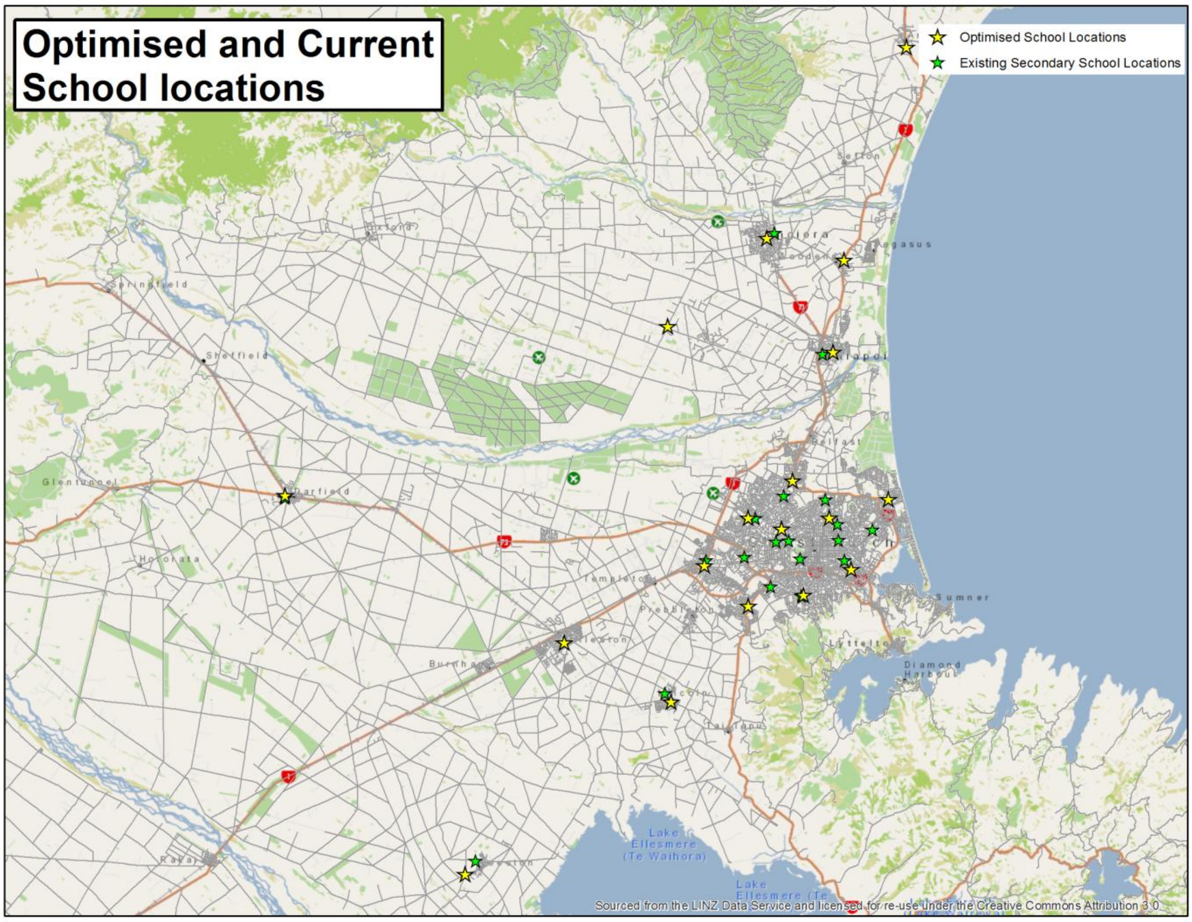

Figure 7: Optimised and current Secondary School locations map

4.6 Zone Generation

The zones generated based on the allocation of students to their closest school are shown in Figures 8 and 9. Figure 8 shows the zones that were generated where gender was taken into account, hence overlaps are present between some zones. Figure 9 shows the zones that were generated when each student was allocated to their closest school regardless of the gender requirements of the school. Generating these sets of zones differs from the current network of enrolment schemes in the Greater Christchurch area (Figure 1), as the generated zones provide every state school with a zone. The Ungendered zones shown in Figure 9 differ from the Gendered zones in Figure 8 as they are mutually exclusive; meaning there is no overlap between the zones. This can make zoning less complicated and easier for a network of zones to be managed, with schools able to be accurately managed to be able to accommodate the potential students within their zone. This zone overlap in the Gendered zone generation is mostly contained around CBHS and CGHS as the only other single sex schools SBHS and AGHS zones are identical in the generation due to them being on the same site.

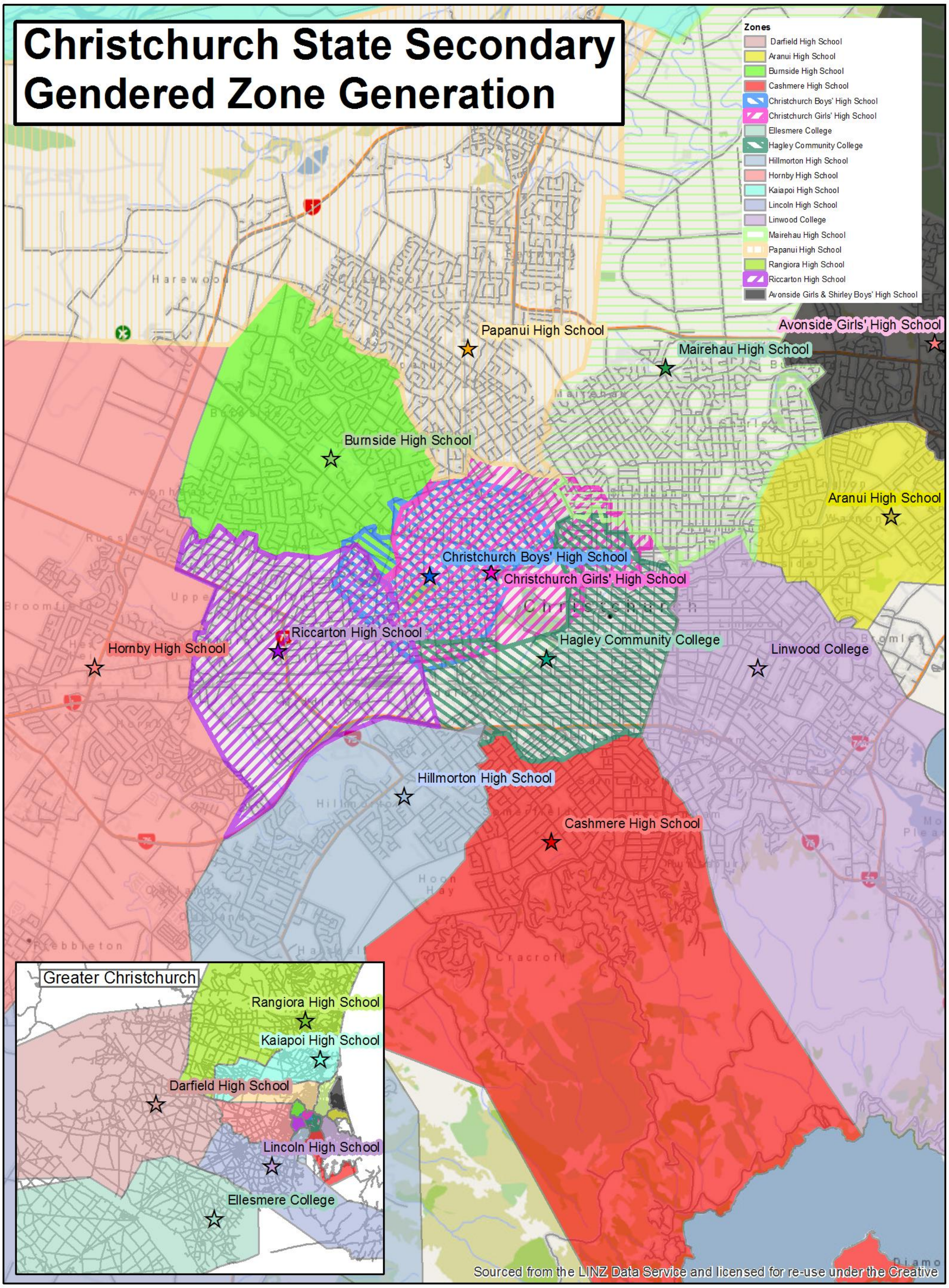

Figure 8: Zones generated from allocating each student to their closest Gendered school

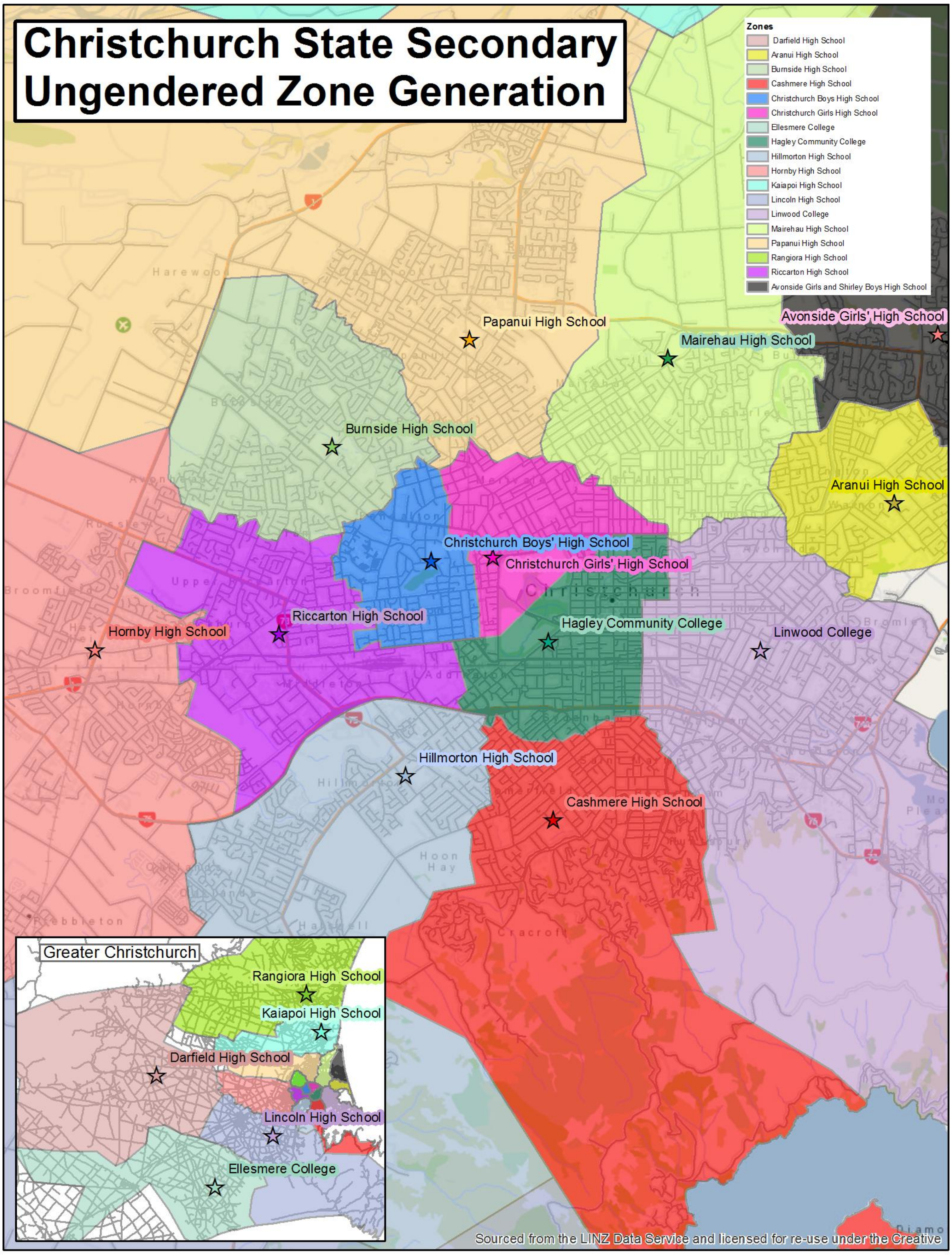

Figure 9: Zones generated from allocating each student to their closest Ungendered Zone

5. Discussion

This chapter will discuss the findings of this research in relation to prior research around the three overarching themes posed. First, that certain school characteristics may make schools more desirable, as seen in the percentage of school's roll that are out-of-zone. Second, that neighbourhood factors such as ethnicity and income could influence the number of children sent out-of-zone for schooling, meshblocks defining the neighbourhood. Third, that allocating students to their local school would have environmental and social benefits.

In addition, this chapter discusses the zones generated around each of the schools studied. There is a critique of the choice of methods used, as well as a discussion of the limitations of the research and potential options for addressing the identified limitations. Finally, the research is summarised and implications of the research identified within the context of parental choice and its potential impact on travel distances.

5.1 School Characteristics and Parental Choice

This research tested different measures of school performance against percentage of out-of-zone enrolments, and found that some variables had a significant correlation, confirming prior research. School achievement has been identified as a factor in parental choice (Rumberger and Willms, 1992; David, 1994; Kane and Staiger, 2005). Ensuring their child receives a good quality education is arguably the fundamental reason for parental choice, where the potential perception that low SES or large minority schools do not perform as well as a higher SES schools can lead to these low SES schools being avoided (Ogawa and Dutton, 1994; Rumberger and Willms,1992). In this research NCEA school achievement rates were used as an indicator of a school's academic quality. However, comparing percentage of out-of-zone enrolments in Christchurch schools with their NCEA achievement rates did not consistently correlate. In fact, the not achieved category of NCEA Level 3 negatively correlated with out-of-zone percentage, but there was no significant correlation at Level 1 and 2. Similarly, the achieved category of NCEA Levels 1 and 3 were not significant, while Level 2 was significant and negatively correlated. On the other hand, NCEA Levels 1, 2, and 3 merit categories were consistent in that they all positively correlated with out-of-zone percentage. That is, in the Christchurch secondary school sector a school with a high out-of-zone percentage is likely to have a higher percentage of students attaining merit in their NCEA studies. The null hypothesis for achievement rates was that the academic achievement rates of a school would have no significant correlation with out-of-zone percentage. Going by the result in this research this null hypothesis can be partially rejected. These results provide some evidence to the conclusion reached in previous research that parents avoid their closest school if there are perceived quality issues with it (Rumberger and Willms, 1992; Waslander and Thrupp, 1995).

Parents may not be aware of this correlation. The data used in this research was available only on request from NZQA. As a result parents may be relying on potentially unverified and anecdotal information to form a perception of school quality when choosing a school for their child (Ball, Bowe, and Gewirtz, 1996). Decile rating in New Zealand has been suggested as an indicator of school quality that parents use when choosing schools (Hill, 2016; Moir, 2016). The results of this research appear to support this assumption as all but two of the NCEA achievement rates consistently correlated with decile rating. High decile schools, or high SES schools, were expected to have higher rates of merit and excellence and subsequently lower rates of not achieved and achieved compared to their low decile/SES counterparts. The findings may however only indicate that higher decile schools achieve higher NCEA results because more academically inclined students are sent to high decile schools (Waslander and Thrupp, 1995). The results generated do support the notion that some parents use decile rating as an indicator of school quality and avoid lower decile schools because of it. However, future qualitative research could investigate the reasons why lower decile schools are perceived to be undesirable by parents, and quantitative could investigate if there is a noticeable difference between low and high decile schools in terms of school quality and other characteristics. This could provide a more detailed evaluation into the effect that decile rating may have on perceived school quality and parental choice.

The quantitative approach of this research differs from the previous studies on parental choice that mainly used surveys to determine what parents found desirable in a school (David, 1994; Kim and Hwang, 2014). The data utilised in this research included quantitative information on different aspects of schools such as, achievement rates, roll size, and percentage of out-of-zone enrolments. This kind of quantitative data is a reliable way for a school to be evaluated by the Ministry of Education. Public opinion may be inconsistent, hard to quantify, or difficult and time consuming to obtain. It is because of the difficulty of surveys (time consuming and low responses) that these statistics were tested to see if an out-of-zone percentage would correlate with information on a school's performance. A quantitative approach discounts a perception of schools that some parents have which does not take an actual school's performance or circumstances into account. The decile rating assumption (Hill, 2016) supports this potential bias, where parents use the rating as an indicator of school quality instead of referring to actual achievement statistics. Curiously in previous research into parental choice, educational quality was cited as an important factor for parents, but how a school was deemed to offer a quality education by the parents was either absent from the methodology or weakly explained (Kim and Hwang, 2014; Marie, Fergusson, and Boden, 2008; Ogawa and Dutton, 1994). This may be because previous research had mostly focused on which factors parents considered when choosing a school, and so asked participants to rate how important academic quality would be in this process (Kim and Hwang, 2014; Schneider et al., 1998a). Further research on how parents formed their opinions, and then the sources parents used to find out the academic quality of the schools would add useful information to the debate surrounding parental choice.

The lack of easily accessible useful statistical information on schools may lead parents to form their opinion on school quality from less reliable sources than official statistics, such as anecdotal evidence or advertisements from the school. While advertisement and anecdotal sources can provide some information this can often be biased or misunderstood. Having easily accessible and understandable supporting statistics could aid parents to make a more informed decision, instead of relying on measures such as decile rating. One possible barrier to offering this information to the public is that if the information disadvantages a school it may fight to keep that information from being released. The data used in this research was specially prepared by the NZQA to show the number of students per school by each level of qualification, which is only available with consent. The main reason why counts are not normally available is because they have the potential to identify individuals if the school or group is small. Percentage data over count data could also potentially benefit smaller schools, or larger schools, depending on what was trying to be ascertained. Having the counts and percentage data would eliminate the potential for such misrepresentations. Whatever the reason, the publically available data shows the cumulative achievement rates for each NCEA Level, which some parents may not be able to easily understand. There are more simple achievement statistics available, but these can be selective. For example, only reporting the percentage who received achieved or higher does not inform about the merit or excellence rates and over emphasises the not achieved rate (Dougan, 2016).

Academic achievement is not the only factor that can determine parental choice of a school. Other factors may include sport programmes, cultural factors, community ties, and proximity. In regards to academic quality however, while some parents may think highly of a school if it has a good pass rate other parents may have different values and so the merit and excellence rates would be useful to them. Having the raw data so that this can be extracted is useful. However, this would require additional statistical knowledge which some parents may not have. If parents exercise choice when sending their child to school in the absence of easily understandable statistical information, they could potentially rely on stereotypes, prejudices, or misinformation to make their decision. It is hoped that data generated in this thesis could be used by parents to help inform them of some data sources that could potentially be used when trying to ascertain school quality, as well as potential consequences of bypassing their closest school.

Percentage of students residing outside of the zone was assumed to be one such indicator of school desirability in this research. The more desirable a school the greater the proportion of its students coming from outside of its zone. This assumption was made as parents would not send their child to a school they were not within zone for without some reason, implying that these schools had some factor that made them desirable. The danger of allowing choice is considered by some to be leading to an educational apartheid (Hill, 2016). Interestingly the out-of-zone percentage only significantly correlated with decile 9 schools in comparison to the lowest decile rating schools with an enrolment scheme. The inherent bias of the lowest decile rating of a school with an enrolment scheme being five may have impacted this result, as many of the lower decile schools could not be compared in this analysis due to their lack of an enrolment scheme; and hence a zone.

This thesis theorised that a school that attracted out-of-zone students would also attract the majority of students within its zone; referred to in this thesis as the market share. This theory could not be confirmed, with the out-of-zone percentage not correlating with the market share of the school. The findings of this research are counter-intuitive to what was thought about desirable schools, however, they do raise a bigger question about whether out-of-zone percentage adequately represents school desirability. If a school is so desirable and likely to be overcrowded then according to the Education Act (1989) an enrolment scheme would be imposed. The implementation of an enrolment scheme would then limit the number of out-of-zone enrolments, with the capacity of the school being taken into account so that it still services the local community. Because of this it was expected that for schools with enrolment schemes they would either have a high market share but a relatively low out-of-zone percentage, or a high out-of-zone percentage and a relatively low market share. The purpose of an enrolment scheme, to prevent overcrowding, was logically hypothesised to cause a school to have a large market share, as the zone should only be large enough to fill the capacity, or if students within zone did not go to it then the school would take students from outside of the zone. This was not the case however, with no significant correlation, positive or negative, being found between school market share and out-of-zone percentage. Because of this the null hypothesis that school out-of-zone percentage had no relationship on school market share was unable to be rejected, and also showed there was no co-linearity between out-of-zone percentage and market share. This analysis comes from the 11 secondary state schools in Greater Christchurch and it would be useful to see if all secondary state schools in New Zealand could provide further insight into whether market share correlates with the out-of-zone percentage.

When testing whether school market share correlated with other school characteristics this study found that all achievement statistics, school leaver's rate, ERO report time difference, and roll size did not significantly correlate with school market share. Decile rating was the only variable that significantly correlated with school market share suggesting that high decile schools tended to have a high market share. This finding further supports the notion that parents in New Zealand use decile rating of a school as an indicator of school quality (Hill, 2016). This result was also only able to be carried out on the schools with zones, meaning that there was already bias in the data as the lowest decile school was 5, and yet it still significantly correlated with the market share. The decile rating did, however, correlate with achievement rates, which may reflect higher decile schools being favoured by parents of high-achieving students. The parents who exercise this choice may also be more involved with their children's education and hence the child performs better (Kim and Hwang, 2014). For this reason it is likely that these students may perform just as well of they were in a lower decile school. High-performing students choosing to go to higher decile schools would then make the high decile schools achievement rates go up, further increasing the divide in perceived academic quality of high and low decile schools(PPTA, 2014; Waslander and Thrupp, 1995) .

Of all the school characteristics tested against out-of-zone percentage the school leaver's rate had the strongest association (r^2 = 0.707; p = 0.001), rejecting the null hypothesis that students leaving before their 17th birthday did not predict out-of-zone student percentage. The school leaver's rate was the percentage of school leavers who were younger than 17, the closest data available to show the number of students who did not pass NCEA per school. This was used as another indicator of school quality, where a school with a high level of non-achievers was assumed to be of lower academic quality. The finding that schools with a low leaver's rate tended to have a high out-of-zone percentage was noteworthy given the strength of the association, and given the number of schools used in this regression (11 excluding AGHS and SBHS), which normally results in a high probability of the data occurring by chance (p-value), and a low percentage of variance in the x-axis being accounted for by the y-axis (r^2). The correlation found despite the small sample size shows the magnitude between these two variables, but the reason behind this relationship is less clear. One explanation could be that because a student is out-of-zone they, or their parents, would have put effort into getting enrolled at that school, and because of that effort there is an incentive for the student to see their education through to NCEA Level 3 and not drop out before their 17^{th} birthday.

Another possibility is that a school with a low school leaver's rate may be considered a good quality school anecdotally, with the school having a good academic reputation. The non-significant result found when the out-of-zone percentage was tested against the school leaver's rate with decile rating as an additional factor indicated that the decile rating combined with the school leaver's rate did not correlate with the out-of-zone percentage; despite the school leaver's rate correlating with the decile rating and out-of-zone percentage separately. This result further strengthens the relationship between the school leaver's rate and the out-of-zone percentage as there was no co-linearity between out-of-zone percentage and decile rating. This finding is still subject to the bias of no low decile (1-4) schools in the study area having zones. Being able to test this relationship against all schools across New Zealand would potentially provide further insight into the effect that the school leaver's rate has on the desirability of a school.

The average time between ERO reports also did not correlate with the out-of-zone percentage, making the null hypothesis that ERO report time difference would correlate out-of-zone percentage unable to be rejected. The time difference between the reports was used as an indicator of how well the school was doing, with the shorter the time the worse the school was doing. As with NCEA results, parents may not know about the ERO reports and hence not use them when selecting a school for their child. Future research could investigate if the ERO reports correlate with measures of school quality, such as the achievement statistics, to see if they could predict school quality. The ERO report time difference was tested against the decile rating, which is seen as an indicator of school quality by parents (Hill, 2016), and the ERO time difference was found to significantly correlate with decile rating. It was found that the high decile schools were visited less often than the lower decile schools, but more intriguing is that the medium decile schools were visited less often than the high decile schools. It would be expected that the higher decile schools would be visited the least often, as higher decile schools are perceived to be better quality (Hill, 2016; Moir, 2016), but the findings of this research does not follow this reasoning. Perhaps the high decile schools are visited more frequently to ensure they keep performing well, and the lower decile schools are visited to ensure the lower income students get the support they need, with the middle decile schools falling between these two spectrums and hence visited less often. This raises the question of whether ERO time difference could help indicate the quality of a school. To answer this the ERO time difference could be tested against the achievement statistics and school leaver's rate which would not suffer from the bias of some schools not having zones. Future research could also test the schools nationwide, which would overcome the small sample size of schools used in the research and investigate whether the out-of-zone percentage truly does not correlate with the ERO report time difference.

Alternative measures of representing the time difference between reports could also be investigated in subsequent research to see whether there is a better way to quantify the time between reports.

Bigger schools can have the capacity to offer more specialised courses than smaller schools, as they have more students to potentially fill these courses, greater capacity to separate students into similar ability classes, and more funding to employ specialist teachers (Lee, Smerdon, Alfeld-Liro, and Brown, 2000). Because of this it is possible that a larger school could seem more desirable due to the increased number of courses it could offer. However the regression analysis in this research found that roll size did not significantly correlate with the out-of-zone percentage or the decile rating. While a large school may be able to offer more varied or specialist courses the greater number of students may make it less desirable with parents fearing bullying or the likelihood of their child being overlooked (Lee et al., 2000). Lee (2000) also found that smaller schools had a greater sense of community, where members of the school were more supportive of students due to the increased time teachers spent with them; which may appeal to some parents. In either case the null hypothesis that school roll size would have an effect on out-of-zone percentage was unable to be rejected.

5.2 Neighbourhood Effects and Schooling

Previous studies suggested that higher SES parents would send their child to a school that they were out-of-zone for, and bypass the local school if it was perceived to be unfavourable (PPTA, 2014; Sampson, Morenoff, and Gannon-Rowley, 2002). Surprisingly the analysis at meshblock level did not find a strong association between an area's median income and the number of students within the area who went out-of-zone for schooling. While the relationship identified did meet the significance level ($p = 0.025$) the r^2 values were very weak suggesting that the data varied widely, with lower median income meshblocks having a similar out-of-zone percentage to higher median income meshblocks. The relationship significance could be related to the number of meshblocks used ($n = 3488$) in the correlation.

Similarly, the relationship between the proportion of Māori in the area did reach significance but had an extremely weak association. The number of meshblocks tested in this correlation may have had an effect of the results, with many areas having a varying proportion of Māori and out-of-zone percentages. This finding seems counter-intuitive to previous research which saw the phenomenon of 'white flight' where NZ European parents diverted their children from schools in low SES/high minority areas (Alexander, Genc, and Jarfoullah, 2001; Marie, Ferguson, and Boden, 2008; Waslander and Thrupp, 1993). The NZ European correlation found similar results, with the percent

NZ European reaching significance but having a weak association. The effect of ethnicity, however, may have been concentrated around a certain part of the city, with the meshblocks around the city being varied enough that if this effect was going on in only one area then it may have been lost within the large number of data points that were collected. An important factor is the small number of Māori in Christchurch, with 41,910 (7.8%) of the 539,436 people of Canterbury identifying themselves as being of Māori descent (Statistics New Zealand, 2013a). Nationally 15% of the population identified as Māori (Statistics New Zealand, 2013b), which is almost twice the rate that is seen in the Canterbury region. The small Maori population present within Canterbury, and hence Christchurch, could also be a reason why the ethnicity based on meshblocks did not correlate with out-of-zone percentage.

The NZ Deprivation Score, which ranked the meshblocks based on deprivation, also significantly correlated but had an extremely low association with the meshblock out-of-zone percentage. This finding again is counter to the previous research which found that low SES households would be less likely to send their children out-of-zone for schooling (Bernal 2005; Hastings, Kane, and Staiger, 2005). The data used, however, were aggregated up to the meshblock level as that was the only level that income and deprivation score were available, and so if individual level data was used the relationship between a student's zoning status and their family's deprivation, income, and ethnicity could be investigated further and a more accurate result could be obtained.

5.3 Environmental and social benefits of allocating students to schools

As expected the results of this research found that allocating students to their closest school did reduce the total distance travelled by students getting to school (Table 9), with the distance saved depending on how each student was allocated to their closest school. Any differences from expected results came from deciding whether private, and state integrated schools should be included in the reallocation, the planned moving of AGHS and SBHS to their new site (Hume and Laureson, 2016), and whether gender should be taken into account (should males be allocated to female schools and vice versa).

The permutations in this research were set to take most of these logistical issues into account when allocating students to their closest school. This helped address the third research question. Although there were multiple permutations, one permutation set was deemed to be the most feasible and suitable to answer the question of what distance could be saved. The Moved-Gendered state-to-state permutation set was chosen as the most feasible scenario. It was the most realistic scenario as the additional enrolment criteria and costs associated with state integrated and private schools would have made some students unable to attend these schools, and hence unsuited to be allocated to them. If each student was hypothetically required to go to their closest secondary school another barrier is that the government does not have direct authority over the state integrated or private schools. While the permutations reallocating students to state integrated and private schools were interesting, the state reallocation was more realistic, as the Ministry of Education is able to actively advise and manage these schools. The moved-gendered state-to-state permutation was chosen over the other state-to-state permutations as the shifting of AGHS and SBHS to their new site would make the unmoved allocation results obsolete after the move. Also allocating a male student to a female only school and vice versa, again would not be feasible.

Using the state-to-state moved-gendered permutation , if each state student was assigned to their closest state school it was found that 79.021.8 kilometres would be saved cumulatively each day, each student travelling about 4.2 kilometres less. Applying this to the environmental effects of travel it was calculated that per day, of those most likely to drive, there would be a net decrease of 156.6 kilograms of CO_2 released into the atmosphere. The carbon calculation did use some assumptions, such as assuming that the fuel efficiency of each car was the same, all the cars were petrol, and anyone travelling further than 2km would drive, in order to be able to calculate the carbon emissions. The assumption made regarding the distance at which students would most likely be driven was based on previous research into transport choice at different distances for primary school students (Black, Collins, and Snell, 2001). If more detailed information was available for each student then that would have made the calculation more accurate. Unfortunately, such data is not available at the scale needed to calculate the exact carbon that could have been saved. The assumptions made, however, are consistent between the current enrolment distances and the closest allocation distances and give a comparison between the carbon emissions released currently, and if each student attended their closest school.

The reduction in pollutants from cars would not only benefit the environment but also have social benefits, such as alleviating respiratory problems (D'Amato et al., 2010). Although there could be social benefits of fewer vehicles on the road, shorter distances do not guarantee that motor vehicles will not be used by parents to transport their children or students driving themselves. The students in this study being secondary school age would suggest that they could utilise other forms of transportation on their own, but because of safety-concerns a parent may still decide to drive their child to school. Safety concerns over the likelihood of their child being hit by a motor vehicle, stranger danger, peer bullying, and uncertainty about their child's whereabouts on their journey to and from school could be reasons why, despite the distance, parents decide to drive their child into school (McDonald, 2005; Sonkin et al., 2011; Wilson, Wilson, and Krizek, 2007). In addition, reducing the distance travelled would minimize the time that these vehicles would be on the road and depending on the distance, perhaps alleviate some of the safety concerns of parents.

The absolute minimum distance that could be travelled was calculated by finding the optimal location for each school so that the sum distance students travelled was the absolute minimum. This analysis used the centroids of a 300m grid covering the extent of the research as the possible locations for schools, and found that placing the 18 schools in the optimal location between the students would result in a cumulative distance of 60,609.48 km. Comparing the absolute minimum distance found in this analysis to the distance when allocating each student to their closest school reinforces the potential distance savings if each student went to their closest school. This is because allocating each student to their closest school would see an approximate decrease of 40,000km, while moving the schools saw an approximate decrease of 60,000km; a relatively small difference considering the amount of effort it would take to move the schools. This research, however, calculated the optimal school location merely to extend the hypothetical scenario of allocating students to schools, and while this gave the absolute lowest distance that students could travel, moving the schools in reality would come into serious issues; making moving schools incredibly difficult if not impossible. If future research were to investigate optimal school locations the land parcel area, land type and, authority owning should be taken into account instead of road intersections. These additional criteria would also limit the sites available, reducing issues encountered in this research where the ArcGIS© software could not handle the number of potential locations.

5.4 Zone Generation

An interesting finding in the analysis was the new roll numbers for each school if the closest students attended the school. The massive increase that some schools would experience suggests that currently those schools are not as sought after as other schools. The market share statistics utilised in the regression analysis measured the phenomenon of students bypassing certain schools. Unfortunately, with not every school in the study having a zone this theory was unable to be tested fully. When allocating the students to their closest school, however, zones were generated to visualise what the distribution of students would look like. These zones, or some kind of catchment polygons, could be used in the future to test whether market share can indicate if a school is being bypassed. The large increases in the rolls observed in the closest allocation analysis would tend to suggest that there is some effect and further investigation into the market share of all schools could provide additional insight.

Generating new zones using the gendered school permutation showed that Christchurch Boys' High School (CBHS) and Christchurch Girls' High School (CGHS) created some complications. Just like their current zones, there was overlap between them, Burnside High School and other surrounding schools. The issue that arose was that some male students were closer to CBHS than Burnside, but some female students within the same area were closer to Burnside than CGHS, creating an overlap. It was for this reason that the moved-ungendered state-to-state permutation was used to generate zones for each state school. Generating zones that disregarded gender had the effect of making the zones mutually exclusive. As mentioned earlier, this saves two schools being required to have a place available for one student, and made the zones generated for CBHS and CGHS mutually exclusive to the zones surrounding them. However, because CBHS cannot take female students, the reasoning behind this was that they could potentially have a similar arrangement to that of SBHS and AGHS. SBHS and AGHS are going to be on the same site, sharing both break times and certain facilities, while keeping single sex classes (Hume and Laurenson, 2016). It is inferred from this that the schools could potentially share a zone as well, and for this reason the allocation based on closest school in this research generated one zone for both AGHS and SBHS. Because of the situation with AGHS and SBHS, the ungendered zone for CBHS and CGHS was generated with the purpose of combining the zones to form one zone for the schools. CGHS has voiced its desire to extend its zone to be the same as CBHS's existing zone (Greenhalgh, 2016). The main rationale behind this extension was that some families could send their sons to single sex education as they were in-zone for CBHS but could not do the same for their daughters as they were out-of-zone for CGHS (Murphy, 2016 June 24). The problem with extending the zone is that CBHS and CGHS are on two different sites with potentially different capacities, and so what works for one school may not necessarily work for the other. The different sites also mean that what is defined as a local catchment for the each school would be different, which is probably why there is an overlap in the current zones. CGHS can also still accept students from out-of-zone, it just means that these students will not have guaranteed entry and would have to rely on the ballot process. A schools teaching spaces, and by flow effect teachers and students, are funded based on the number of in-zone students, and so for CGHS extending the zone could potentially increase the amount of funding they could receive. Allocating each state student to their closest state school actually decreased the rolls for CBHS and CGHS in this scenario and so combining the ungendered zones of these schools would have actually decreased the number of students who could be considered in zone.

5.5 Limitations

The 2014 school NCEA achievement rates were used in this study as the 2015 NCEA results were not yet available when this research was being carried out. The achievement rates from the previous year would most likely have had an effect on enrolments in the following year, and so the 2015 March geocoded roll return data were used to compare with the achievement rates. The 2016 March geocoded roll returns were available, but because the achievement statistics were not the 2015 data was used instead. This meant that current trends may not have been represented in this research, such as Aranui High School becoming Haeata Community Campus in 2017, and future research could look at the effects of the new community school and if the achievement trends changed from 2014.

Being able to compare the low and high decile schools in terms of how many students came from inside and outside of their local catchment would have been ideal, but school zones are the only official catchment that a school has, and secondary schools in Greater Christchurch with deciles less than 5 do not have zones. The distance the average student travelled to get to school, however, could potentially be used in future research to be able to compare schools with zones to schools without zones. Alternatively the zones based on closest distance generated in this research could similarly be used to compare the zoning status of students to school characteristics.

This research only investigated the enrolment patterns of secondary schools in the Greater Christchurch area, and so the relationships found may not apply to the whole country. Future research could apply this to the whole of New Zealand and investigate what relationships arise and if they are the same as those identified in this research.

While state integrated and private schools were included in some of the transport allocation permutations, it was decided that for the carbon analysis and zone generation that only the state secondary schools would be used. This was decided as state integrated and private schools are not directly responsible to, or managed, by the government. State integrated and private schools also have other entry criteria, such as religious affiliation or interviews, and higher schooling fees compared to state schools, making them unsuited when considering the allocation of students to these schools based on proximity. Excluding the state integrated and private school students from the carbon calculation meant that there could be more carbon released into the air from school travel than reported here. For the zone generation, this exclusion means that there are potentially more students within the zones than reported, as well as additional education options not taken into account by the mutually exclusive zones. Because of the fundamental differences between these types of schools there is no way to incorporate these students into the state network reallocation. This is because the reallocation would come into issues of enrolments and the equal opportunity for students to attend these schools. The only way to get around these limits would be to keep the state students and schools completely separate from the state integrated and private, and draw up a reallocation and zone network for state integrated and private schools separately. Private schools are privately run, and so can be selective, expensive, and are an alternative to fully state funded schools, so reallocating students, or generating zones for private schools would not be appropriate.

When calculating the school travel distance saved, this analysis allocated each student to their closest school, which resulted in a notable change in some school rolls. This allocation, however, failed to take the capacity of the school into account. Arguably the closest school to each student ideally would be their local school and have capacity for them, but schools going in and out of favour and schools without zones can complicate the process of school capacity. The financial costs, and the time it takes to build new classrooms can also further contribute to school capacity issues. If maximum capacity numbers for schools were known then this could have been incorporated into the analysis, and prevented schools from being allocated more students than they can physically accommodate. Unfortunately the maximum capacity numbers of the schools could not be obtained in this study, due to the sensitive nature and variability of absolute capacities. Capacity can vary as ideal student teacher ratios change per year level, and although the number of physical teaching spaces may not change, the capacity the school can vary over time. This can make reporting capacity numbers sensitive as parents could complain of their child being excluded and quoting to their being more students at the school in previous years, and coupled with the fact that the school's capacity is also linked to its funding can make capacity a sensitive issue (Ministry of Education, 2016). In future research the capacity for each school could be used when allocating each student to their closest school and thus limit the students based on how many a school could physically take. Taking the capacity of a school into account was attempted in this analysis by using the rolls as a substitute for capacity, but this is unreliable as some schools could be running well under or over capacity. It is possible that the number of classrooms a school has, and a uniform assumption of classroom size, could be used to calculate potential school capacity in future research.

6. Conclusion and Implications of Research

Zoning policy within Christchurch remains an issue of public discussion for several reasons including, some schools seen as having large out-of-zone rolls (Law, 2016), Christchurch Girls' High School wanting to extend their current enrolment scheme (Murphy, 2016 June 24), and schools in low SES areas concerned about being bypassed in favour of schools in High SES neighbourhoods, which may lead to a possible 'educational apartheid' (Hill, 2016). this apartheid can be caused by the rise of parental choice, where parents avoid a school that they perceive to be of poor quality in favour of a school with more desirable traits (Kim and Hwang, 2014; Waslander and Thrupp, 1995). The option of choice can see the emergence of prejudice where schools can be avoided based on perceived quality issues, such as thinking that low socio-economic-status or high ethnic minority schools are less successful than other schools. A school with a high percentage of out-of-zone enrolments was assumed to mean that the school was highly sought after and desirable. Therefore investigating which characteristics correlated with out-of-zone percentage could give a school community an indication of what made a school desirable. This research hence looked at the possible relationships between a school's characteristics and its out-of-zone percentage to identify which characteristics of a school were desirable by correlating with the out-of-zone percentage. Previous research has looked at different school and individual factors that can influence which school parents send their children too. However, these studies have relied upon parental surveys and opinion to ascertain school characteristics that are desirable, and the background of a parent that would facilitate choice (Bernal, 2005; David, 1994; Schneider, 1988b).

In comparison this thesis utilised a quantitative approach to test the possible relationship between a secondary school's desirability and its characteristics, within the Greater Christchurch area of New Zealand. For this purpose the percentage of out-of-zone enrolments a school had was calculated from student addresses in the March 2015 school roll return data and was used as an indicator of a school's desirability, with a desirable school attracting a high proportion of their students from outside of their zone. Analysing quantitative statistical information instead of individual opinions can allow schools, or the MoE, to more easily gauge what aspects a school may need to change to improve parent perception, and hence make it more desirable, reducing the number of parents bypassing their local school.

Using data from Greater Christchurch secondary schools the research questions this thesis sought to answer were, which school characteristics correlated with a school's out-of-zone percentage, which potential neighbourhood effect correlated with a meshblock's out-of-zone percentage, and to quantify the distance that could be saved if each secondary school student went to their closest school.

In regards to the first question, this research found that there was a significant correlation between a school's out-of-zone percentage and some of its characteristics, especially as regards to the school leaver's rate and the NCEA Level 1,2, and 3 Merit achievement rates. Many of the other achievement statistics did not consistently correlate with the out-of-zone percentage. For example NCEA Level 2 Achieved did significantly correlate but the Level 1 and 3 rates did not, Merit being the only achievement rating that consistently correlated with the out-of-zone percentage across all the NCEA levels. The roll size, school market share and the frequency of ERO reports all did not significantly correlate with the out-of-zone percentage, while decile rating was only found to significantly correlate with out-of-zone percentage in the decile 9 schools (when using the lowest decile school with a zone as the reference variable). The school leaver's rate was the most interesting result as it had a strong association (r^2 =0.707) suggesting that a school with fewer of its students leaving before their 17th birthday has higher out-of-zone percentages. This relationship between a school's merit rate, school leaver's rate and out-of-zone percentage suggests that a school with a high proportion of its students achieving merit in NCEA, and a small proportion of its students leaving school before their 17th birthday can be seen as desirable. This result could indicate that a low school leaver's rate makes a school more desirable, but further research is needed to understand this relationship as this was only carried out on schools with zones within the Greater Christchurch area. Interestingly the regression also suggested that a school with a high out-of-zone percentage did not necessarily attract most of the students from within its zone, with the school market share not significantly correlated school out-of-zone percentage.

The out-of-zone analysis however, was limited to secondary schools which had an enrolment scheme, thus excluding the low decile schools because the lowest decile rating of a school with a zone in the Greater Christchurch area is 5. To overcome this potential bias decile rating ,which in the media appears to be used by parents as an indicator of school quality, was tested for correlation with the other school characteristics. The analysis found that when grouping the decile ratings into low (2-4), medium (5-7), and high (8-10), the NCEA achievement rate, frequency of ERO reports, and school leaver's rate all correlated with a high decile rating. Although the decile rating only correlated with the out-of-zone percentage at the highest decile schools, in conjunction with decile rating analysis, this study does support the suggestion that higher decile schools are perceived to be of better quality by parents. However, a more in-depth analysis on school preference could provide further insights into the effect of decile rating.

In regards to the second question, due to previous research finding individual factors could influence parental choice (Bernal, 2005; Hastings, Kane, and Staiger, 2005; Rumberger and Willms, 1992) this thesis also tested to see whether demographic statistics of a meshblock would correlate with the percentage of students who went out-of-zone for schooling. The results of this regression, however, were inconclusive, with the Māori percentage, deprivation score and income of each meshblock reaching significance but having a very weak association with meshblock out-of-zone percentage. Future research could investigate this further, by testing whether ethnicity of a student or their family's income correlate with each student's zoning status. To get a definitive answer to this question, however, income data would need to be available at the individual level to allow comparisons an individual's ethnicity. Ethically this may not be possible.

In regards to the third and final question, the effect of a student being sent out-of-zone for schooling due to school preference can result in students travelling further to school, which has associated environmental and social impacts (Müller et al., 2008; Tscharaktschiew and Haase, 2008). The exact transport implications of this avoidance, such as environmental pollution, has not to date been quantified. The transport analysis in this thesis found that if Greater Christchurch secondary state students were allocated to their closest gender appropriate state school, there would be a sum transport saving of 79.021.8km a day compared to where the students went to school in March of 2015. This equates to a 156.6kg reduction in CO_2 emissions per day. The distance saved if all students went to their local school was investigated in order to quantify the environmental impact if each student went to their local school. This finding shows that if each student went to their local school then there would be a sum decrease in the distance students would travel, potentially increasing child and road safety (McDonald, 2005; McDonald and Aalborg, 2009) and reducing pollutants such as CO_2 from school related travel. Zones were subsequently drawn around each school to encompass the students who were closest to each school to show what the enrolment patterns could look like if each student went to their closest school. The major implication, other than the transport benefits, of this reallocation was how the rolls for each school changed, with some schools receiving large increases in their rolls. The difference between the current roll and allocation based on closest distance shows that some schools are being bypassed, conforming with reports of some schools having large out-of-zone percentages (Law, 2016). If a local school is defined as being the most reasonably convenient school or closest school, then it would need to be investigated whether schools could cope with this potential increase if students were assigned based on proximity. If schools could not cope with the potential increases then, because the reallocation in this thesis was done without having a defined maximum capacity for each school, future research could take the potential capacity for a school into account when reallocating students to further test the savings if each student attended their closest school. The reallocation undertaken, however, was showing the best case scenario if all schools were of equal quality or perceived quality, and showed the potential benefits if schools were not bypassed and if schools only took the students who were within their local area.

In conclusion, the analysis carried out in this thesis gave insights into possible relationships between a school's out-of-zone percentage and some of its characteristics, and quantified the transport implications of students bypassing their closest schools. The characteristics that had a relationship with the out-of-zone percentage can be used by schools, or government authorities, to better understand what school characteristics may attract students to schools they are not within zone for. Quantifying the distance saved if students went to their local school highlights some of the benefits that can result from better understanding why some schools are preferred over others.

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7. Appendix 1 - Out of zone regression with Decile Rating as a factor

Significant values in **bold**

NCEA Level 1 Merit + Decile Rating			
Decile Rating	Coefficient	CI 2.5 — 97.5	p value
5	1	-	-
6	13.351	-22.66 — 49.36	0.384
7	26.72	-10.13 — 63.57	0.121
8	6.409	-22.58 — 35.40	0.594
9	26.333	-9.32 — 62.00	0.116

NCEA Level 2 Merit + Decile Rating			
Decile Rating	Coefficient	CI 2.5 — 97.5	p value
5	1	-	-
6	9.574	-31.47 — 50.62	0.575
7	25.819	-15.95 — 67.59	0.173
8	5.419	-27.77 — 38.61	0.692
9	26.23	-15.46 — 67.92	0.167

NCEA Level 3 Merit + Decile Rating			
Decile Rating	Coefficient	CI 2.5 — 97.5	p value
5	1	-	-
6	21.025	-20.77 — 62.82	0.252
7	18.7	-28.54 — 65.93	0.356
8	10.382	-21.91 — 42.67	0.446
9	**36.378**	**0.50 — 72.26**	**0.048**

Left Before 17th Birthday + Decile Rating			
Decile Rating	Coefficient	CI 2.5 — 97.5	p value
5	1	-	-
6	-11.047	-47.28 — 25.19	0.469
7	-9.658	-54.99 — 35.67	0.607
8	-28.075	-68.11 — 11.96	0.131
9	-18.97	-74.52 — 36.58	0.42

8. Appendix 2 - Decile Rating linear regression

Decile rating as dependent variable

NCEA Level 1 Not Achieved			
Decile Rating Groupings	Coefficient	CI 2.5 — 97.5	P value
1 (Low decile)	1	-	-
2	0.33	-10.11 — 10.77	0.95
3 (High decile)	-8.24	-17.88 — 1.40	0.09

NCEA Level 1 Achieved			
Decile Rating Groupings	Coefficient	CI 2.5 — 97.5	P value
1 (Low decile)	1	-	-
2	-11.90	-27.82 — 4.01	0.14
3 (High decile)	**-25.30**	**-39.99 — -10.61**	**0.002**

NCEA Level 1 Merit			
Decile Rating Groupings	Coefficient	CI 2.5 — 97.5	P value
1 (Low decile)	1	-	-
2	7.29	-5.12 — 19.70	0.24
3 (High decile)	**16.07**	**4.62 — 27.53**	**0.008**

NCEA Level 1 Excellence			
Decile Rating Groupings	Coefficient	CI 2.5 — 97.5	P value
1 (Low decile)	1	-	-
2	4.28	-8.8 — 17.30	0.5
3 (High decile)	**17.47**	**5.4 — 29.50**	**0.006**

NCEA Level 2 Not Achieved			
Decile Rating Groupings	Coefficient	CI 2.5 — 97.5	P value
1 (Low decile)	1	-	-
2	-3.42	-11.73 — 4.88	0.4
3 (High decile)	**-8.91**	**-16.58 — -1.25**	**0.025**

NCEA Level 2 Achieved			
Decile Rating Groupings	**Coefficient**	**CI 2.5 — 97.5**	**P value**
1 (Low decile)	1	-	-
2	-9.8	-23.09 —3.5	0.14
3 (High decile)	**-21.94**	**-34.21 — -9.67**	**0.001**

NCEA Level 2 Merit			
Decile Rating Groupings	**Coefficient**	**CI 2.5 —97.5**	**P value**
1 (Low decile)	1	-	-
2	8.47	-2.01 — 18.95	0.11
3 (High decile)	**17.33**	**7.65 — 27**	**0.001**

NCEA Level 2 Excellence			
Decile Rating Groupings	**Coefficient**	**CI 2.5 — 97.5**	**P value**
1 (Low decile)	1	-	-
2	4.75	-2.89 — 12.39	0.211
3 (High decile)	**13.53**	**6.47 — 20.58**	**0.0006**

NCEA Level 3 Not Achieved			
Decile Rating Groupings	**Coefficient**	**CI 2.5 — 97.5**	**P value**
1 (Low decile)	1	-	-
2	-5.98	-19.04 — 7.07	0.35
3 (High decile)	**-14.52**	**-26.57 — -2.46**	**0.02**

NCEA Level 3 Achieved			
Decile Rating Groupings	**Coefficient**	**CI 2.5 — 97.5**	**P value**
1 (Low decile)	1	-	-
2	-0.32	-11.31 — 10.66	0.95
3 (High decile)	-8	-18.14 — 2.14	0.12

NCEA Level 3 Merit			
Decile Rating Groupings	**Coefficient**	**CI 2.5 — 97.5**	**P value**
1 (Low decile)	1	-	-
2	2.59	-8.6 — 13.77	0.64
3 (High decile)	**12.41**	**2.09 — 22.73**	**0.02**

NCEA Level 3 Excellence

Decile Rating Groupings	Coefficient	CI 2.5 — 97.5	P value
1 (Low decile)	1	-	-
2	3.72	-2.69 — 10.13	0.24
3 (High decile)	**10.1**	**4.18 — 16.02**	**0.001**

School Leaver's Rate

Decile Rating Groupings	Coefficient	CI 2.5 —97.5	P value
1 (Low decile)	1	-	-
2	**-13.37**	**-22.9 — -3.84**	**0.008**
3 (High decile)	**-22.41**	**-31.21 — -13.61**	**<0.001**

ERO Average time difference

Decile Rating Groupings	Coefficient	CI 2.5 — 97.5	P value
1 (Low decile)	1	-	-
2	**13.77**	**5.9 — 21.63**	**0.001**
3 (High decile)	**8.805**	**1.55 — 16.06**	**0.02**

9. Appendix 3 - Moved Gendered Permutation sets

School Name	Current Roll	SIP to SIP roll	SI to SI roll	S to S roll	S to SI roll	S to SIP roll
Christ's College	445	100	N/A	N/A	N/A	N/A
Rangi Ruru Girls' School	419	87	N/A	N/A	N/A	N/A
St Andrew's College (Christchurch)	788	875	N/A	N/A	N/A	N/A
St Margaret's College	403	183	N/A	N/A	N/A	N/A
Catholic Cathedral College	337	277	311	N/A	N/A	N/A
Christchurch Adventist School	90	306	688	N/A	N/A	N/A
Marian College	419	160	153	N/A	N/A	N/A
Middleton Grange School	789	291	279	N/A	N/A	N/A
St Bedes College	663	602	547	N/A	N/A	N/A
St Thomas of Canterbury College	443	296	290	N/A	N/A	N/A
Villa Maria College	682	340	325	N/A	N/A	N/A
Aranui High School	356	1,037	1,025	892	1,025	1,037
Avonside Girls' High School	869	699	670	559	670	699
Burnside High School	2,434	1,996	1,842	1,809	2,009	2,182
Cashmere High School	1,807	1,729	1,568	1,481	1,680	1,845
Christchurch Boys' High School	1,174	449	371	407	446	651
Christchurch Girls' High School	891	249	321	402	445	652
Darfield High School	422	452	424	379	424	452
Ellesmere College	335	373	369	354	369	373
Hagley Community College	1,031	285	309	289	370	392
Hillmorton High School	587	1,340	1,272	922	1,272	1,340
Hornby High School	449	1,723	1,610	1,330	1,730	1,844
Kaiapoi High School	666	1,088	982	868	984	1,090
Lincoln High School	1,505	1,631	1,556	1,372	1,556	1,631
Linwood College	559	2,102	1,879	1,745	2,119	2,348
Mairehau High School	362	1,167	1,218	1,125	1,410	1,545
Papanui High School	1,486	1,361	1,255	1,726	2,176	2,518
Rangiora High School	1,746	2,222	2,122	1,995	2,122	2,222
Riccarton High School	896	153	151	556	730	752
Shirley Boys' High School	1,193	673	654	557	654	673
Grand Total	**24,246**	**24,246**	**22,191**	**18,768**	**22,191**	**24,246**
Total State	18,768	20,729	19,598			
Total State Integrated	3,423	2,272	2,593			
Total Private	2,055	1,245				

Sum distance travelled in Kilometres

School Name	Current Sum	SIP to SIP Sum	SI to SI Sum	S to S Sum	S to SI Sum	S to SIP Sum
Christ's College	3,645.67	156.62	N/A	N/A	N/A	N/A
Rangi Ruru Girls' School	3,827.45	81.26	N/A	N/A	N/A	N/A
St Andrew's College (Christchurch)	8,426.60	1,051.38	N/A	N/A	N/A	N/A
St Margaret's College	4,395.82	232.93	N/A	N/A	N/A	N/A
Catholic Cathedral College	1,801.04	530.06	623.88	N/A	N/A	N/A
Christchurch Adventist School	597.85	287.15	1,022.14	N/A	N/A	N/A
Marian College	4,447.32	370.58	350.24	N/A	N/A	N/A
Middleton Grange School	7,655.78	357.13	337.22	N/A	N/A	N/A
St Bedes College	6,487.20	1,451.11	1,269.83	N/A	N/A	N/A
St Thomas of Canterbury College	4,538.66	525.75	515.53	N/A	N/A	N/A
Villa Maria College	6,454.27	577.41	557.86	N/A	N/A	N/A
Aranui High School	1,122.44	2,515.06	2,470.63	2,072.98	2,470.63	2,515.06
Avonside Girls' High School	5,889.45	1,784.43	1,696.13	1,402.06	1,696.13	1,784.43
Burnside High School	12,042.48	3,397.72	3,119.86	3,120.31	3,506.90	3,827.85
Cashmere High School	7,487.78	5,568.90	4,980.04	4,596.55	5,289.41	5,891.34
Christchurch Boys' High School	7,949.28	521.15	462.92	564.99	623.17	965.65
Christchurch Girls' High School	5,854.73	353.79	524.57	729.20	814.83	1,163.60
Darfield High School	5,774.62	5,374.65	4,888.13	4,293.53	4,888.13	5,374.65
Ellesmere College	3,374.36	3,972.31	3,747.10	3,344.60	3,747.10	3,972.31
Hagley Community College	8,434.19	429.34	489.59	530.24	655.93	707.51
Hillmorton High School	2,202.42	3,913.65	3,574.02	2,501.89	3,574.02	3,913.65
Hornby High School	1,203.52	8,603.49	7,434.37	5,858.19	7,788.95	8,960.61
Kaiapoi High School	3,768.59	5,376.91	4,716.46	4,157.15	4,732.33	5,392.78
Lincoln High School	14,625.38	15,224.16	14,637.62	12,884.43	14,637.62	15,224.16
Linwood College	2,051.32	9,360.26	7,572.99	6,488.06	8,159.17	9,962.77
Mairehau High School	1,974.09	2,597.61	2,685.29	2,596.37	3,204.40	3,562.02
Papanui High School	6,437.59	3,643.27	3,270.62	4,564.87	5,830.58	6,800.93
Rangiora High School	16,313.02	20,350.08	19,023.16	18,128.14	19,023.16	20,350.08
Riccarton High School	4,066.65	217.75	213.50	994.45	1,334.93	1,377.13
Shirley Boys' High School	9,134.76	1,671.49	1,613.04	1,367.75	1,613.04	1,671.49
Grand Total	**171,984.33**	**100,497.39**	**91,796.73**	**80,195.78**	**93,590.43**	**103,418.01**
Total State	119,706.67	94,876.00	87,120.04			
Total State Integrated	31,982.12	4,099.20	4,676.70			
Total Private	20,295.54	1,522.19				

Average distance travelled in Kilometres

School Name	Current Average	SIP to SIP Average	SI to SI Average	S to S Average	S to SI Average	S to SIP Average
Christ's College	8.19	1.57	N/A	N/A	N/A	N/A
Rangi Ruru Girls' School	9.13	0.93	N/A	N/A	N/A	N/A
St Andrew's College (Christchurch)	10.69	1.20	N/A	N/A	N/A	N/A
St Margaret's College	10.91	1.27	N/A	N/A	N/A	N/A
Catholic Cathedral College	5.34	1.91	2.01	N/A	N/A	N/A
Christchurch Adventist School	6.64	0.94	1.49	N/A	N/A	N/A
Marian College	10.61	2.32	2.29	N/A	N/A	N/A
Middleton Grange School	9.70	1.23	1.21	N/A	N/A	N/A
St Bedes College	9.78	2.41	2.32	N/A	N/A	N/A
St Thomas of Canterbury College	10.25	1.78	1.78	N/A	N/A	N/A
Villa Maria College	9.46	1.70	1.72	N/A	N/A	N/A
Aranui High School	3.15	2.43	2.41	2.32	2.41	2.43
Avonside Girls' High School	6.78	2.55	2.53	2.51	2.53	2.55
Burnside High School	4.95	1.70	1.69	1.72	1.75	1.75
Cashmere High School	4.14	3.22	3.18	3.10	3.15	3.19
Christchurch Boys' High School	6.77	1.16	1.25	1.39	1.40	1.48
Christchurch Girls' High School	6.57	1.42	1.63	1.81	1.83	1.78
Darfield High School	13.68	13.12	12.84	11.33	12.84	13.12
Ellesmere College	10.07	11.13	10.64	9.95	10.64	11.13
Hagley Community College	8.18	1.51	1.58	1.83	1.77	1.80
Hillmorton High School	3.75	2.92	2.81	2.71	2.81	2.92
Hornby High School	2.68	4.99	4.62	4.40	4.50	4.86
Kaiapoi High School	5.66	4.94	4.80	4.79	4.81	4.95
Lincoln High School	9.72	9.33	9.41	9.39	9.41	9.33
Linwood College	3.67	4.45	4.03	3.72	3.85	4.24
Mairehau High School	5.45	2.23	2.20	2.31	2.27	2.31
Papanui High School	4.33	2.68	2.61	2.64	2.68	2.70
Rangiora High School	9.34	9.58	9.41	9.56	9.41	9.58
Riccarton High School	4.54	1.42	1.41	1.79	1.83	1.83
Shirley Boys' High School	7.66	2.48	2.47	2.46	2.47	2.48
Grand Total	**7.09**	**4.14**	**4.14**	**4.27**	**4.22**	**4.27**
Total State	6.38	4.58	4.45			
Total State Integrated	9.34	1.80	1.80			
Total Private	9.88	1.22				

Median distance travelled in Kilometres

School Name	Current Median	SIP to SIP Median	SI to SI Median	S to S Median Distance	S to SI Median	S to SIP Median
Christ's College	5.54	1.66	N/A	N/A	N/A	N/A
Rangi Ruru Girls' School	5.98	0.87	N/A	N/A	N/A	N/A
St Andrew's College (Christchurch)	7.25	1.20	N/A	N/A	N/A	N/A
St Margaret's College	7.50	1.23	N/A	N/A	N/A	N/A
Catholic Cathedral College	4.11	1.90	2.07	N/A	N/A	N/A
Christchurch Adventist School	3.97	0.92	1.57	N/A	N/A	N/A
Marian College	8.66	2.20	2.17	N/A	N/A	N/A
Middleton Grange School	7.62	1.28	1.26	N/A	N/A	N/A
St Bedes College	6.46	2.17	2.05	N/A	N/A	N/A
St Thomas of Canterbury College	7.01	1.84	1.85	N/A	N/A	N/A
Villa Maria College	7.12	1.64	1.66	N/A	N/A	N/A
Aranui High School	2.06	1.89	1.89	1.84	1.89	1.89
Avonside Girls' High School	5.16	2.57	2.53	2.44	2.53	2.57
Burnside High School	2.36	1.64	1.63	1.68	1.70	1.70
Cashmere High School	2.50	1.92	1.91	1.96	1.96	1.97
Christchurch Boys' High School	3.90	1.19	1.24	1.38	1.39	1.49
Christchurch Girls' High School	3.44	1.40	1.59	1.85	1.88	1.84
Darfield High School	12.55	10.53	9.88	9.17	9.88	10.53
Ellesmere College	8.49	8.37	8.37	8.37	8.37	8.37
Hagley Community College	6.18	1.53	1.57	1.74	1.67	1.69
Hillmorton High School	2.49	2.90	2.78	2.24	2.78	2.90
Hornby High School	1.62	2.77	2.50	2.54	2.66	2.82
Kaiapoi High School	3.67	3.59	3.43	3.30	3.44	3.62
Lincoln High School	10.57	10.58	10.65	10.62	10.65	10.58
Linwood College	2.67	2.67	2.45	2.40	2.45	2.63
Mairehau High School	5.68	1.75	1.84	2.09	2.04	2.11
Papanui High School	3.00	2.37	2.27	2.26	2.30	2.32
Rangiora High School	6.05	6.19	6.14	6.19	6.14	6.19
Riccarton High School	3.10	0.98	0.98	1.81	1.81	1.82
Shirley Boys' High School	5.19	2.39	2.37	2.32	2.37	2.39
Grand Total	**4.38**	**2.11**	**2.16**	**2.26**	**2.29**	**2.31**
Total State	3.71	2.31	2.26			
Total State Integrated	6.92	1.64	1.71			
Total Private	6.51	1.22				

10. Appendix 4 - Moved Ungendered Permutation sets

School Name	Current Roll	SIP to SIP roll	SI to SI roll	S to S roll	S to SI roll	S to SIP roll
Christ's College	445	36	N/A	N/A	N/A	N/A
Rangi Ruru Girls' School	419	144	N/A	N/A	N/A	N/A
St Andrew's College (Christchurch)	788	751	N/A	N/A	N/A	N/A
St Margaret's College	403	310	N/A	N/A	N/A	N/A
Catholic Cathedral College	337	180	207	N/A	N/A	N/A
Christchurch Adventist School	90	305	631	N/A	N/A	N/A
Marian College	419	323	311	N/A	N/A	N/A
Middleton Grange School	789	201	197	N/A	N/A	N/A
St Bedes College	663	1,236	1,113	N/A	N/A	N/A
St Thomas of Canterbury College	443	409	399	N/A	N/A	N/A
Villa Maria College	682	395	379	N/A	N/A	N/A
Aranui High School	356	1,034	1,022	889	1,022	1,034
Avonside Girls' High School	869	-	-	-	-	-
Burnside High School	2,434	1,904	1,764	1,762	1,956	2,106
Cashmere High School	1,807	1,671	1,514	1,481	1,680	1,845
Christchurch Boys' High School	1,174	701	549	568	645	830
Christchurch Girls' High School	891	176	369	470	513	803
Darfield High School	422	452	424	379	424	452
Ellesmere College	335	373	369	354	369	373
Hagley Community College	1,031	255	266	224	294	302
Hillmorton High School	587	1,340	1,272	922	1,272	1,340
Hornby High School	449	1,677	1,565	1,330	1,730	1,844
Kaiapoi High School	666	1,082	977	868	984	1,090
Lincoln High School	1,505	1,631	1,556	1,372	1,556	1,631
Linwood College	559	2,086	1,864	1,745	2,119	2,348
Mairehau High School	362	1,146	1,203	1,103	1,383	1,509
Papanui High School	1,486	743	705	1,691	2,136	2,461
Rangiora High School	1,746	2,222	2,122	1,995	2,122	2,222
Riccarton High School	896	88	86	496	659	681
Shirley Boys' High School	1,193	1,375	1,327	1,119	1,327	1,375
Grand Total	**24,246**	**24,246**	**22,191**	**18,768**	**22,191**	**24,246**
Total State	18,772	19,956	18,954			
Total State Integrated	3,524	3,049	3,237			
Total Private	2,055	1,241				

Sum distance travelled in Kilometres

School Name	Current Sum	SIP to SIP Sum	SI to SI Sum	S to S Sum	S to SI Sum	S to SIP Sum
Christ's College	3,645.67	28.35	N/A	N/A	N/A	N/A
Rangi Ruru Girls' School	3,827.45	119.86	N/A	N/A	N/A	N/A
St Andrew's College (Christchurch)	8,426.60	847.19	N/A	N/A	N/A	N/A
St Margaret's College	4,395.82	395.75	N/A	N/A	N/A	N/A
Catholic Cathedral College	1,801.04	339.25	406.46	N/A	N/A	N/A
Christchurch Adventist School	597.85	285.97	888.87	N/A	N/A	N/A
Marian College	4,447.32	739.10	704.16	N/A	N/A	N/A
Middleton Grange School	7,655.78	187.42	183.58	N/A	N/A	N/A
St Bedes College	6,487.20	3,073.82	2,664.28	N/A	N/A	N/A
St Thomas of Canterbury College	4,538.66	655.13	639.24	N/A	N/A	N/A
Villa Maria College	6,454.27	619.81	598.17	N/A	N/A	N/A
Aranui High School	1,122.44	2,505.11	2,460.69	2,063.03	2,460.69	2,505.11
Avonside Girls' High School	5,889.45	-	-	-	-	-
Burnside High School	12,042.48	3,212.35	2,958.58	3,020.69	3,394.20	3,669.18
Cashmere High School	7,487.78	5,396.67	4,821.52	4,596.55	5,289.41	5,891.34
Christchurch Boys' High School	7,949.28	768.37	614.37	688.18	792.10	1,011.81
Christchurch Girls' High School	5,854.73	170.02	586.48	828.34	915.76	1,384.00
Darfield High School	5,774.62	4,793.50	5,469.28	4,293.53	4,888.13	5,374.65
Ellesmere College	3,374.36	3,783.64	3,935.77	3,344.60	3,747.10	3,972.31
Hagley Community College	8,434.19	373.12	389.80	360.14	456.92	471.38
Hillmorton High School	2,202.42	3,913.65	3,574.02	2,501.89	3,574.02	3,913.65
Hornby High School	1,203.52	8,479.08	7,313.40	5,858.19	7,788.95	8,960.61
Kaiapoi High School	3,768.59	5,326.67	4,675.08	4,157.15	4,732.33	5,392.78
Lincoln High School	14,625.38	15,224.16	14,637.62	12,884.43	14,637.62	15,224.16
Linwood College	2,051.32	9,304.30	7,518.72	6,488.06	8,159.17	9,962.77
Mairehau High School	1,974.09	2,523.60	2,625.76	2,530.11	3,123.19	3,454.73
Papanui High School	6,437.59	1,404.17	1,315.61	4,474.79	5,727.89	6,651.79
Rangiora High School	16,313.02	19,380.55	19,992.69	18,128.14	19,023.16	20,350.08
Riccarton High School	4,066.65	120.56	116.31	859.28	1,173.99	1,216.19
Shirley Boys' High School	9,134.76	3,438.32	3,292.71	2,757.71	3,292.71	3,438.32
Grand Total	**171,984.33**	**97,409.47**	**92,383.12**	**79,834.81**	**93,177.33**	**102,844.85**
Total Puplic	119,706.67	90,117.82	86,298.37			
Total State Integrated	31,982.12	5,900.50	6,084.75			
Total Private	20,295.54	1,391.14				

Average distance travelled in Kilometres

School Name	Current Average	SIP to SIP Average	SI to SI Average	S to S Average	S to SI Average	S to SIP Average
Christ's College	8.19	0.79	N/A	N/A	N/A	N/A
Rangi Ruru Girls' School	9.13	0.83	N/A	N/A	N/A	N/A
St Andrew's College (Christchurch)	10.69	1.13	N/A	N/A	N/A	N/A
St Margaret's College	10.91	1.28	N/A	N/A	N/A	N/A
Catholic Cathedral College	5.34	1.88	1.96	N/A	N/A	N/A
Christchurch Adventist School	6.64	0.94	1.41	N/A	N/A	N/A
Marian College	10.61	2.29	2.26	N/A	N/A	N/A
Middleton Grange School	9.70	0.93	0.93	N/A	N/A	N/A
St Bedes College	9.78	2.49	2.39	N/A	N/A	N/A
St Thomas of Canterbury College	10.25	1.60	1.60	N/A	N/A	N/A
Villa Maria College	9.46	1.57	1.58	N/A	N/A	N/A
Aranui High School	3.15	2.42	2.41	2.32	2.41	2.42
Avonside Girls' High School	6.78	0.00	0.00	0.00	0.00	0.00
Burnside High School	4.95	1.69	1.68	1.71	1.74	1.74
Cashmere High School	4.14	3.23	3.18	3.10	3.15	3.19
Christchurch Boys' High School	6.77	1.10	1.12	1.21	1.23	1.22
Christchurch Girls' High School	6.57	0.97	1.59	1.76	1.79	1.72
Darfield High School	13.68	13.12	12.84	11.33	12.84	13.12
Ellesmere College	10.07	11.13	10.64	9.95	10.64	11.13
Hagley Community College	8.18	1.46	1.47	1.61	1.55	1.56
Hillmorton High School	3.75	2.92	2.81	2.71	2.81	2.92
Hornby High School	2.68	5.06	4.67	4.40	4.50	4.86
Kaiapoi High School	5.66	4.92	4.79	4.79	4.81	4.95
Lincoln High School	9.72	9.33	9.41	9.39	9.41	9.33
Linwood College	3.67	4.46	4.03	3.72	3.85	4.24
Mairehau High School	5.45	2.20	2.18	2.29	2.26	2.29
Papanui High School	4.33	1.89	1.87	2.65	2.68	2.70
Rangiora High School	9.34	9.58	9.41	9.56	9.41	9.58
Riccarton High School	4.54	1.37	1.35	1.73	1.78	1.79
Shirley Boys' High School	7.66	2.50	2.48	2.46	2.48	2.50
Grand Total	**7.09**	**4.02**	**4.16**	**4.25**	**4.20**	**4.24**
Total Puplic	6.38	4.52	4.55			
Total State Integrated	9.08	1.94	1.88			
Total Private	9.88	1.12				

Median distance travelled in Kilometres

School Name	Current Median	SIP to SIP Median	SI to SI Median	S to S Median	S to SI Median	S to SIP Median
Christ's College	5.54	0.94	N/A	N/A	N/A	N/A
Rangi Ruru Girls' School	5.98	0.77	N/A	N/A	N/A	N/A
St Andrew's College (Christchurch)	7.25	1.10	N/A	N/A	N/A	N/A
St Margaret's College	7.50	1.20	N/A	N/A	N/A	N/A
Catholic Cathedral College	4.11	1.84	2.08	N/A	N/A	N/A
Christchurch Adventist School	3.97	0.92	1.51	N/A	N/A	N/A
Marian College	8.66	2.20	2.15	N/A	N/A	N/A
Middleton Grange School	7.62	0.93	0.93	N/A	N/A	N/A
St Bedes College	6.46	2.25	2.17	N/A	N/A	N/A
St Thomas of Canterbury College	7.01	1.69	1.70	N/A	N/A	N/A
Villa Maria College	7.12	1.51	1.51	N/A	N/A	N/A
Aranui High School	2.06	1.89	1.89	1.84	1.89	1.89
Avonside Girls' High School	5.16	0.00	0.00	0.00	0.00	0.00
Burnside High School	2.36	1.60	1.60	1.66	1.68	1.67
Cashmere High School	2.50	1.90	1.87	1.96	1.96	1.97
Christchurch Boys' High School	3.90	1.11	1.12	1.19	1.22	1.22
Christchurch Girls' High School	3.44	1.01	1.54	1.81	1.83	1.78
Darfield High School	12.55	10.53	9.88	9.17	9.88	10.53
Ellesmere College	8.49	8.37	8.37	8.37	8.37	8.37
Hagley Community College	6.18	1.49	1.49	1.60	1.55	1.55
Hillmorton High School	2.49	2.90	2.78	2.24	2.78	2.90
Hornby High School	1.62	2.79	2.48	2.54	2.66	2.82
Kaiapoi High School	3.67	3.58	3.37	3.30	3.44	3.62
Lincoln High School	10.57	10.58	10.65	10.62	10.65	10.58
Linwood College	2.67	2.67	2.43	2.40	2.45	2.63
Mairehau High School	5.68	1.74	1.82	2.04	1.99	2.06
Papanui High School	3.00	1.70	1.69	2.24	2.29	2.29
Rangiora High School	6.05	6.19	6.14	6.19	6.14	6.19
Riccarton High School	3.10	0.51	0.51	1.70	1.73	1.73
Shirley Boys' High School	5.19	2.47	2.45	2.36	2.45	2.47
Grand Total	**4.38**	**2.06**	**2.10**	**2.22**	**2.26**	**2.27**
Total Puplic	3.71	2.25	2.21			
Total State Integrated	6.92	1.69	1.69			
Total Private	6.51	1.07				

11. Appendix 5 - Unmoved Gendered Permutation sets

School Name	Current Roll	SIP to SIP roll	SI to SI roll	S to S roll	S to SI roll	S to SIP roll
Christ's College	445	98	N/A	N/A	N/A	N/A
Rangi Ruru Girls' School	419	87	N/A	N/A	N/A	N/A
St Andrew's College (Christchurch)	788	874	N/A	N/A	N/A	N/A
St Margaret's College	403	183	N/A	N/A	N/A	N/A
Catholic Cathedral College	337	166	180	N/A	N/A	N/A
Christchurch Adventist School	90	306	686	N/A	N/A	N/A
Marian College	419	160	153	N/A	N/A	N/A
Middleton Grange School	789	291	279	N/A	N/A	N/A
St Bedes College	663	602	547	N/A	N/A	N/A
St Thomas of Canterbury College	443	296	290	N/A	N/A	N/A
Villa Maria College	682	340	325	N/A	N/A	N/A
Aranui High School	356	1,794	1,756	1,521	1,756	1,794
Avonside Girls' High School	869	285	288	274	314	323
Burnside High School	2,434	1,996	1,842	1,809	2,009	2,182
Cashmere High School	1,807	1,729	1,568	1,481	1,680	1,845
Christchurch Boys' High School	1,174	449	371	407	446	651
Christchurch Girls' High School	891	249	321	395	437	643
Darfield High School	422	452	424	379	424	452
Ellesmere College	335	373	369	354	369	373
Hagley Community College	1,031	285	309	258	334	350
Hillmorton High School	587	1,340	1,272	922	1,272	1,340
Hornby High School	449	1,723	1,610	1,330	1,730	1,844
Kaiapoi High School	666	1,088	982	868	984	1,090
Lincoln High School	1,505	1,631	1,556	1,372	1,556	1,631
Linwood College	559	1,997	1,776	1,574	1,935	2,159
Mairehau High School	362	1,430	1,458	1,263	1,588	1,736
Papanui High School	1,486	1,361	1,255	1,726	2,176	2,518
Rangiora High School	1,746	2,222	2,122	1,995	2,122	2,222
Riccarton High School	896	153	151	556	730	752
Shirley Boys' High School	1,193	286	301	284	329	341
Grand Total	**24,246**	**24,246**	**22,191**	**18,768**	**22,191**	**24,246**
Total Public	18,768	20,849	19,737			
Total StateIntegrated	3,423	2,161	2,460			
Total Private	2,055	1,242				

Sum distance travelled in Kilometres

School Name	Current Sum	SIP to SIP Sum	SI to SI Sum	S to S Sum	S to SI Sum	S to SIP Sum
Christ's College	3,645.67	151.75	N/A	N/A	N/A	N/A
Rangi Ruru Girls' School	3,827.45	81.26	N/A	N/A	N/A	N/A
St Andrew's College (Christchurch)	8,426.60	1,048.89	N/A	N/A	N/A	N/A
St Margaret's College	4,395.82	232.93	N/A	N/A	N/A	N/A
Catholic Cathedral College	1,801.04	276.20	312.40	N/A	N/A	N/A
Christchurch Adventist School	597.85	287.15	1,016.04	N/A	N/A	N/A
Marian College	4,447.32	370.58	350.24	N/A	N/A	N/A
Middleton Grange School	7,655.78	357.13	337.22	N/A	N/A	N/A
St Bedes College	6,487.20	1,451.11	1,269.83	N/A	N/A	N/A
St Thomas of Canterbury College	4,538.66	525.75	515.53	N/A	N/A	N/A
Villa Maria College	6,454.27	577.41	557.86	N/A	N/A	N/A
Aranui High School	1,122.44	6,137.00	5,944.56	5,065.45	5,944.56	6,137.00
Avonside Girls' High School	5,537.66	426.25	440.14	417.82	486.09	500.20
Burnside High School	12,042.48	3,397.72	3,119.86	3,120.31	3,506.90	3,827.85
Cashmere High School	7,487.78	5,568.90	4,980.04	4,596.55	5,289.41	5,891.34
Christchurch Boys' High School	7,949.28	521.15	462.92	564.99	623.17	965.65
Christchurch Girls' High School	5,854.73	353.79	524.57	709.33	791.93	1,137.87
Darfield High School	5,774.62	5,374.65	4,888.13	4,293.53	4,888.13	5,374.65
Ellesmere College	3,374.36	3,972.31	3,747.10	3,344.60	3,747.10	3,972.31
Hagley Community College	8,434.19	429.34	489.59	438.62	550.64	584.55
Hillmorton High School	2,202.42	3,913.65	3,574.02	2,501.89	3,574.02	3,913.65
Hornby High School	1,203.52	8,603.49	7,434.37	5,858.19	7,788.95	8,960.61
Kaiapoi High School	3,768.59	5,376.91	4,716.46	4,157.15	4,732.33	5,392.78
Lincoln High School	14,625.38	15,224.16	14,637.62	12,884.43	14,637.62	15,224.16
Linwood College	2,051.32	9,163.20	7,379.64	6,118.14	7,761.68	9,553.51
Mairehau High School	1,974.09	4,449.28	4,431.24	3,861.20	4,764.60	5,199.22
Papanui High School	6,437.59	3,643.27	3,270.62	4,564.87	5,830.58	6,800.93
Rangiora High School	16,313.02	20,350.08	19,023.16	18,128.14	19,023.16	20,350.08
Riccarton High School	4,066.65	217.75	213.50	994.45	1,334.93	1,377.13
Shirley Boys' High School	8,574.24	406.95	453.31	449.18	526.00	552.30
Grand Total	**171,072.01**	**102,890.00**	**94,089.96**	**82,068.86**	**95,801.79**	**105,715.79**
Total State	118,794.35	97,529.83	89,730.85			
Total State Integrated	31,982.12	3,845.34	4,359.11			
Total Private	20,295.54	1,514.83				

Average distance travelled in Kilometres

School Name	Current Average	SIP to SIP Average	SI to SI Average	S to S Average	S to SI Average	S to SIP Average
Christ's College	8.19	1.55	N/A	N/A	N/A	N/A
Rangi Ruru Girls' School	9.13	0.93	N/A	N/A	N/A	N/A
St Andrew's College (Christchurch)	10.69	1.20	N/A	N/A	N/A	N/A
St Margaret's College	10.91	1.27	N/A	N/A	N/A	N/A
Catholic Cathedral College	5.34	1.66	1.74	N/A	N/A	N/A
Christchurch Adventist School	6.64	0.94	1.48	N/A	N/A	N/A
Marian College	10.61	2.32	2.29	N/A	N/A	N/A
Middleton Grange School	9.70	1.23	1.21	N/A	N/A	N/A
St Bedes College	9.78	2.41	2.32	N/A	N/A	N/A
St Thomas of Canterbury College	10.25	1.78	1.78	N/A	N/A	N/A
Villa Maria College	9.46	1.70	1.72	N/A	N/A	N/A
Aranui High School	3.15	3.42	3.39	3.33	3.39	3.42
Avonside Girls' High School	6.37	1.50	1.53	1.52	1.55	1.55
Burnside High School	4.95	1.70	1.69	1.72	1.75	1.75
Cashmere High School	4.14	3.22	3.18	3.10	3.15	3.19
Christchurch Boys' High School	6.77	1.16	1.25	1.39	1.40	1.48
Christchurch Girls' High School	6.57	1.42	1.63	1.80	1.81	1.77
Darfield High School	13.68	11.89	11.53	11.33	11.53	11.89
Ellesmere College	10.07	10.65	10.15	9.45	10.15	10.65
Hagley Community College	8.18	1.51	1.58	1.70	1.65	1.67
Hillmorton High School	3.75	2.92	2.81	2.71	2.81	2.92
Hornby High School	2.68	4.99	4.62	4.40	4.50	4.86
Kaiapoi High School	5.66	4.94	4.80	4.79	4.81	4.95
Lincoln High School	9.72	9.33	9.41	9.39	9.41	9.33
Linwood College	3.67	4.59	4.16	3.89	4.01	4.42
Mairehau High School	5.45	3.11	3.04	3.06	3.00	2.99
Papanui High School	4.33	2.68	2.61	2.64	2.68	2.70
Rangiora High School	9.34	9.16	8.96	9.09	8.96	9.16
Riccarton High School	4.54	1.42	1.41	1.79	1.83	1.83
Shirley Boys' High School	7.19	1.42	1.51	1.58	1.60	1.62
Grand Total	**7.06**	**4.24**	**4.24**	**4.37**	**4.32**	**4.36**
Total State	6.33	4.68	4.55			
Total State Integrated	9.34	1.78	1.77			
Total Private	9.88	1.22				

Median distance travelled in Kilometres

School Name	Current Median	SIP to SIP Median	SI to SI Median	S to S Median	S to SI Median	S to SIP Median
Christ's College	5.54	1.65	N/A	N/A	N/A	N/A
Rangi Ruru Girls' School	5.98	0.87	N/A	N/A	N/A	N/A
St Andrew's College (Christchurch)	7.25	1.20	N/A	N/A	N/A	N/A
St Margaret's College	7.50	1.23	N/A	N/A	N/A	N/A
Catholic Cathedral College	4.11	1.59	1.71	N/A	N/A	N/A
Christchurch Adventist School	3.97	0.92	1.57	N/A	N/A	N/A
Marian College	8.66	2.20	2.17	N/A	N/A	N/A
Middleton Grange School	7.62	1.28	1.26	N/A	N/A	N/A
St Bedes College	6.46	2.17	2.05	N/A	N/A	N/A
St Thomas of Canterbury College	7.01	1.84	1.85	N/A	N/A	N/A
Villa Maria College	7.12	1.64	1.66	N/A	N/A	N/A
Aranui High School	2.06	3.53	3.47	3.43	3.47	3.53
Avonside Girls' High School	4.59	1.45	1.52	1.49	1.52	1.52
Burnside High School	2.36	1.64	1.63	1.68	1.70	1.70
Cashmere High School	2.50	1.92	1.91	1.96	1.96	1.97
Christchurch Boys' High School	3.90	1.19	1.24	1.38	1.39	1.49
Christchurch Girls' High School	3.44	1.40	1.59	1.83	1.86	1.84
Darfield High School	12.55	10.53	9.88	9.17	9.88	10.53
Ellesmere College	8.49	8.37	8.37	8.37	8.37	8.37
Hagley Community College	6.18	1.53	1.57	1.68	1.60	1.61
Hillmorton High School	2.49	2.90	2.78	2.24	2.78	2.90
Hornby High School	1.62	2.77	2.50	2.54	2.66	2.82
Kaiapoi High School	3.67	3.59	3.43	3.30	3.44	3.62
Lincoln High School	10.57	10.58	10.65	10.62	10.65	10.58
Linwood College	2.67	2.81	2.58	2.46	2.55	2.70
Mairehau High School	5.68	2.27	2.30	2.43	2.37	2.38
Papanui High School	3.00	2.37	2.27	2.26	2.30	2.32
Rangiora High School	6.05	6.19	6.14	6.19	6.14	6.19
Riccarton High School	3.10	0.98	0.98	1.81	1.81	1.82
Shirley Boys' High School	5.50	1.36	1.39	1.43	1.47	1.48
Grand Total	**4.32**	**2.15**	**2.20**	**2.30**	**2.34**	**2.36**
Total State	3.66	2.41	2.35			
Total State Integrated	6.92	1.60	1.66			
Total Private	6.51	1.22				

12. Appendix 6 - Unmoved Ungendered Permutation sets

School Name	Current Roll	SIP to SIP roll	SI to SI roll	S to S roll	S to SI roll	S to SIP roll
Christ's College	445	36	N/A	N/A	N/A	N/A
Rangi Ruru Girls' School	419	144	N/A	N/A	N/A	N/A
St Andrew's College (Christchurch)	788	751	N/A	N/A	N/A	N/A
St Margaret's College	403	288	N/A	N/A	N/A	N/A
Catholic Cathedral College	337	49	61	N/A	N/A	N/A
Christchurch Adventist School	90	305	631	N/A	N/A	N/A
Marian College	419	323	311	N/A	N/A	N/A
Middleton Grange School	789	201	197	N/A	N/A	N/A
St Bedes College	663	1,236	1,113	N/A	N/A	N/A
St Thomas of Canterbury College	443	409	399	N/A	N/A	N/A
Villa Maria College	682	395	379	N/A	N/A	N/A
Aranui High School	356	1,761	1,723	1,493	1,723	1,761
Avonside Girls' High School	869	308	304	313	343	350
Burnside High School	2,434	1,904	1,764	1,762	1,956	2,106
Cashmere High School	1,807	1,671	1,514	1,481	1,680	1,845
Christchurch Boys' High School	1,174	701	549	568	645	830
Christchurch Girls' High School	891	176	349	439	478	764
Darfield High School	422	452	424	379	424	452
Ellesmere College	335	373	369	354	369	373
Hagley Community College	1,031	255	266	208	275	281
Hillmorton High School	587	1,340	1,272	922	1,272	1,340
Hornby High School	449	1,677	1,565	1,330	1,730	1,844
Kaiapoi High School	666	1,082	977	868	984	1,090
Lincoln High School	1,505	1,631	1,556	1,372	1,556	1,631
Linwood College	559	1,899	1,679	1,485	1,835	2,059
Mairehau High School	362	1,336	1,354	1,176	1,480	1,611
Papanui High School	1,486	743	705	1,691	2,136	2,461
Rangiora High School	1,746	2,222	2,122	1,995	2,122	2,222
Riccarton High School	896	88	86	496	659	681
Shirley Boys' High School	1,193	490	522	436	524	545
Grand Total	**24,246**	**24,246**	**22,191**	**18,768**	**22,191**	**24,246**
Total State	18,768	20,109	19,100			
Total State Integrated	3,423	2,918	3,091			
Total Private	2,055	1,219				

Sum distance travelled in Kilometres

School Name	Current Sum	SIP to SIP Sum	SI to SI Sum	S to S Sum	S to SI Sum	S to SIP Sum
Christ's College	3,645.67	28.35	N/A	N/A	N/A	N/A
Rangi Ruru Girls' School	3,827.45	119.86	N/A	N/A	N/A	N/A
St Andrew's College (Christchurch)	8,426.60	847.19	N/A	N/A	N/A	N/A
St Margaret's College	4,395.82	343.11	N/A	N/A	N/A	N/A
Catholic Cathedral College	1,801.04	57.18	82.52	N/A	N/A	N/A
Christchurch Adventist School	597.85	285.97	888.87	N/A	N/A	N/A
Marian College	4,865.42	739.10	704.16	N/A	N/A	N/A
Middleton Grange School	7,655.78	187.42	183.58	N/A	N/A	N/A
St Bedes College	6,725.18	3,073.82	2,664.28	N/A	N/A	N/A
St Thomas of Canterbury College	4,538.66	655.13	639.24	N/A	N/A	N/A
Villa Maria College	6,454.27	619.81	598.17	N/A	N/A	N/A
Aranui High School	1,122.44	6,052.68	5,860.23	4,994.75	5,860.23	6,052.68
Avonside Girls' High School	5,537.66	348.97	345.62	373.16	410.30	419.71
Burnside High School	12,042.48	3,212.35	2,958.58	3,020.69	3,394.20	3,669.18
Cashmere High School	7,487.78	5,396.67	4,821.52	4,596.55	5,289.41	5,891.34
Christchurch Boys' High School	7,949.28	768.37	614.37	688.18	792.10	1,011.81
Christchurch Girls' High School	5,854.73	170.02	531.24	741.72	817.75	1,274.96
Darfield High School	5,774.62	4,793.50	5,469.28	4,293.53	4,888.13	5,374.65
Ellesmere College	3,374.36	3,783.64	3,935.77	3,344.60	3,747.10	3,972.31
Hagley Community College	9,060.73	373.12	389.80	318.60	408.34	418.03
Hillmorton High School	2,202.42	3,913.65	3,574.02	2,501.89	3,574.02	3,913.65
Hornby High School	1,203.52	8,479.08	7,313.40	5,858.19	7,788.95	8,960.61
Kaiapoi High School	3,768.59	5,326.67	4,675.08	4,157.15	4,732.33	5,392.78
Lincoln High School	14,625.38	15,224.16	14,637.62	12,884.43	14,637.62	15,224.16
Linwood College	2,051.32	8,964.62	7,182.74	5,958.76	7,583.26	9,375.09
Mairehau High School	1,974.09	4,231.58	4,183.20	3,666.82	4,520.14	4,912.08
Papanui High School	6,843.47	1,404.17	1,315.61	4,474.79	5,727.89	6,651.79
Rangiora High School	16,313.02	19,380.55	19,992.69	18,128.14	19,023.16	20,350.08
Riccarton High School	4,281.17	120.56	116.31	859.28	1,173.99	1,216.19
Shirley Boys' High School	8,574.24	673.51	764.77	636.74	770.03	809.51
Grand Total	**172,975.03**	**99,574.81**	**94,442.64**	**81,497.97**	**95,138.94**	**104,890.61**
Total State	120,041.28	92,617.86	88,681.83			
Total State Integrated	32,638.20	5,618.44	5,760.81			
Total Private	20,295.54	1,338.51				

Average distance travelled in Kilometres

School Name	Current Average	SIP to SIP Average	SI to SI Average	S to S Average	S to SI Average	S to SIP Average
Christ's College	8.19	0.79	N/A	N/A	N/A	N/A
Rangi Ruru Girls' School	9.13	0.83	N/A	N/A	N/A	N/A
St Andrew's College (Christchurch)	10.69	1.13	N/A	N/A	N/A	N/A
St Margaret's College	10.91	1.19	N/A	N/A	N/A	N/A
Catholic Cathedral College	5.34	1.17	1.35	N/A	N/A	N/A
Christchurch Adventist School	6.64	0.94	1.41	N/A	N/A	N/A
Marian College	11.58	2.29	2.26	N/A	N/A	N/A
Middleton Grange School	9.70	0.93	0.93	N/A	N/A	N/A
St Bedes College	10.13	2.49	2.39	N/A	N/A	N/A
St Thomas of Canterbury College	10.25	1.60	1.60	N/A	N/A	N/A
Villa Maria College	9.46	1.57	1.58	N/A	N/A	N/A
Aranui High School	3.15	3.44	3.40	3.35	3.40	3.44
Avonside Girls' High School	6.37	1.13	1.14	1.19	1.20	1.20
Burnside High School	4.95	1.69	1.68	1.71	1.74	1.74
Cashmere High School	4.14	3.23	3.18	3.10	3.15	3.19
Christchurch Boys' High School	6.77	1.10	1.12	1.21	1.23	1.22
Christchurch Girls' High School	6.57	0.97	1.52	1.69	1.71	1.67
Darfield High School	13.68	13.12	12.84	11.33	12.84	13.12
Ellesmere College	10.07	11.13	10.64	9.95	10.64	11.13
Hagley Community College	8.77	1.46	1.47	1.53	1.48	1.49
Hillmorton High School	3.75	2.92	2.81	2.71	2.81	2.92
Hornby High School	2.68	5.06	4.67	4.40	4.50	4.86
Kaiapoi High School	5.66	4.92	4.79	4.79	4.81	4.95
Lincoln High School	9.72	9.33	9.41	9.39	9.41	9.33
Linwood College	3.67	4.72	4.28	4.01	4.13	4.55
Mairehau High School	5.45	3.17	3.09	3.12	3.05	3.05
Papanui High School	4.60	1.89	1.87	2.65	2.68	2.70
Rangiora High School	9.34	9.58	9.41	9.56	9.41	9.58
Riccarton High School	4.77	1.37	1.35	1.73	1.78	1.79
Shirley Boys' High School	7.19	1.37	1.47	1.46	1.47	1.49
Grand Total	**7.13**	**4.11**	**4.26**	**4.34**	**4.29**	**4.33**
Total State	6.40	4.61	4.64			
Total State Integrated	9.53	1.93	1.86			
Total Private	9.88	1.10				

Median distance travelled in Kilometres

School Name	Current Median	SIP to SIP Median	SI to SI Median	S to S Median	S to SI Median	S to SIP Median
Christ's College	5.54	0.94	N/A	N/A	N/A	N/A
Rangi Ruru Girls' School	5.98	0.77	N/A	N/A	N/A	N/A
St Andrew's College (Christchurch)	7.25	1.10	N/A	N/A	N/A	N/A
St Margaret's College	7.50	1.16	N/A	N/A	N/A	N/A
Catholic Cathedral College	4.11	1.13	1.22	N/A	N/A	N/A
Christchurch Adventist School	3.97	0.92	1.51	N/A	N/A	N/A
Marian College	8.66	2.20	2.15	N/A	N/A	N/A
Middleton Grange School	7.62	0.93	0.93	N/A	N/A	N/A
St Bedes College	6.46	2.25	2.17	N/A	N/A	N/A
St Thomas of Canterbury College	7.01	1.69	1.70	N/A	N/A	N/A
Villa Maria College	7.12	1.51	1.51	N/A	N/A	N/A
Aranui High School	2.06	3.58	3.54	3.46	3.54	3.58
Avonside Girls' High School	4.59	1.16	1.16	1.20	1.20	1.20
Burnside High School	2.36	1.60	1.60	1.66	1.68	1.67
Cashmere High School	2.50	1.90	1.87	1.96	1.96	1.97
Christchurch Boys' High School	3.90	1.11	1.12	1.19	1.22	1.22
Christchurch Girls' High School	3.44	1.01	1.49	1.76	1.78	1.74
Darfield High School	12.55	10.53	9.88	9.17	9.88	10.53
Ellesmere College	8.49	8.37	8.37	8.37	8.37	8.37
Hagley Community College	6.18	1.49	1.49	1.56	1.51	1.52
Hillmorton High School	2.49	2.90	2.78	2.24	2.78	2.90
Hornby High School	1.62	2.79	2.48	2.54	2.66	2.82
Kaiapoi High School	3.67	3.58	3.37	3.30	3.44	3.62
Lincoln High School	10.57	10.58	10.65	10.62	10.65	10.58
Linwood College	2.67	3.00	2.65	2.61	2.64	2.81
Mairehau High School	5.68	2.39	2.36	2.46	2.42	2.42
Papanui High School	3.00	1.70	1.69	2.24	2.29	2.29
Rangiora High School	6.05	6.19	6.14	6.19	6.14	6.19
Riccarton High School	3.10	0.51	0.51	1.70	1.73	1.73
Shirley Boys' High School	5.50	1.29	1.35	1.33	1.35	1.37
Grand Total	**4.32**	**2.06**	**2.12**	**2.26**	**2.29**	**2.31**
Total Public	3.66	2.32	2.26			
Total StateIntegrated	6.92	1.66	1.66			
Total Private	6.51	1.06				

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