The economic and land use impacts of transformational transport investment

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Abbreviations and acronyms

AADT	average annual daily traffic
AM	active mode
ANZSIC	Australian and New Zealand Standard Industrial Classification
ARGS	Auckland Regional Growth Strategy
BERL	Business and Economic Research Ltd
CAU	Census Area Unit
EEM	Economic Evaluation Manual
EIA	economic impact assessment
FoRST	Foundation for Research, Science and Technology
GPS	Government Policy Statement
PPFM	*Planning, programming and funding manual*
PT	public transport
QVNZ	Quotable Value New Zealand
RDC	Rodney District Council
SH	state highway
SNZ	Statistics New Zealand
TOD	transit-oriented development
WTP	willingness to pay

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Executive summary

Purpose and scope

The purpose of this research project was to develop, test and recommend additional methodologies that could be used by the transport infrastructure providers to quantify the economic productivity and land use impacts when assessing transformational or structural transport investments over time.

Currently there is a knowledge gap in this area, meaning there is no certainty that the 'best' investment decisions are being made by transport infrastructure providers. The intention was to develop a more strategic approach to funding allocation that would assist transport infrastructure providers in gaining greater value for money from future transport investments. The research project was undertaken between July 2010 and June 2011.

This research purpose was as follows:

- Can we utilise available information on revealed preferences for land to inform the assessment of the productivity[1] and land use effects of transformational/structural transport investment over time?
- Can this be applied by transport infrastructure providers to contribute towards decision making that will deliver greater value for money?

The key output from the project was to be 'an economic impact assessment tool or framework that provides a way of evaluating projects *before* they are put through a detailed analysis such as the *Economic evaluation manual* (EEM) process'. This was considered to be the best approach to enable or support integrated land use and transport planning. An early assessment of a project (prior to a detailed analysis such as a full EEM evaluation) would be most likely to lead to changes in the scope or priority of projects to support better economic and land use outcomes. This approach was therefore consistent with the aim of better integrating transport and land use planning decisions.

Land values as indicators of productivity and land use changes arising from transport investments

Economic theory predicts a positive relationship between improved accessibility and increased productivity, and between increased productivity and increased land (or property) values. These relationships can be expected to be positive with respect to an improvement in accessibility.

Land values for commercial uses reveal the productive value of a given location. The value of adjacent land available for commercial uses can be a good indicator of the effectiveness of a transport solution in promoting accessibility, economic exchange and productivity. As one author observed, agglomeration benefits are expected to be capitalised into land values and rents

For residential properties, land values will partly reflect the ability of people in the area to access employment opportunities. Improving access to more productive areas will be expected to increase the demand for residential accommodation in a given area and therefore, the value of the land in that area.

The main drawback associated with land values in project appraisal is that the effects we are interested in will only be likely to be *fully* reflected in future prices. So although land values can be an ideal *ex post* indicator of the real benefits of a project, to be equally useful as an *ex ante* indicator we would need to be

[1] See the Introduction section for definitions.

confident we could obtain proxy values from observed data. The transferability of these values, from *ex post* observation to *ex ante* assessment, was a key consideration. Our investigations confirmed that 'transferability' could be enhanced through the adoption of a number of steps, the first being the building up of a series of internally consistent case studies, necessary to understand the complex range of interactions going on at the local level over time.

Identifying land use changes

An important component of this study was the consideration of the types of land use changes that could arise from transformational transport investments, and whether information on property values could provide a useful indicator of these changes. Land use and property values are closely related, as both reflect changes in the same basic factor – the demand for land. Land values are a price signal and can act as an indicator of land use change as firms and residents respond to these signals. Research we reviewed found that local factors strongly influence land use changes arising from transport investments. Therefore an understanding of these factors is critical if changes are to be predicted. We addressed this through the development of the qualitative assessment tool.

Preferred approach

Our research confirmed that there is no single tool or methodology that is able to provide a comprehensive analysis of the relationship between transport investment and land use change. However, a qualitative case study approach offers the possibility of a providing a useable tool in the short term, if we are able to identify sufficiently generic comparator projects that can be defined as being 'transformational', and that can then be used to provide an information base against which proposed projects could be compared. We noted that the qualitative tool would be more capable of providing insights into land use effects, which could then be further interpreted to assist in revealing productivity effects. A quantitative regression tool would then be a key instrument in the more rigorous assessment of productivity changes. A staged approach to development will allow the gradual refinement and quantification of the evaluation tool. A qualitative tool will be useful in the short term and also provides the richness needed to accompany a regression-based quantitative analysis.

The preferred methodology is a case study approach, using qualitative indicators and descriptive statistics, as a starting point prior to the development of a more sophisticated and complementary quantitative model.

The key features of the case study tool are as follows:

- It can rely on the analysis of single or multiple case studies where a similar project has already been implemented. Transferability of data to the new situation is the key requirement.
- It derives estimates of effects by comparing 'before' and 'after' conditions, generating a time series comparison. The advantage of this approach is that it allows a picture to be built up of what has been actually happening in response to the project over time.
- It can provide information regarding the nature of changes in surrounding land use following the announcement, building and completion of projects.

Case study findings

We then considered how the qualitative case study tool worked in practice, based on the application to the Silverdale Motorway Interchange project.

Our investigation indicated that focusing on a broad range of indicators to supplement information on land values appears to be a useful starting point in the assessment of land use changes arising from a transformational transport investment, whilst also providing some indication of the productivity benefits at the local (micro) level. One way in which we noted that productivity effects could be discerned from the qualitative analysis was through the assessment of the changes in employment and sectoral composition within the case study area. At the next stage of the analysis, the regression tool could be developed to assess the extent to which land values reflect these changes.

Overall, the case study approach was considered to provide a useful starting point in the assessment of land use changes arising from a transformational transport investment. Extending into a quantitative analysis, using a regression tool that can work interactively with the qualitative findings, would add greater rigour and also predictive power over time.

Fit within planning process

The intention of this research was to add to the development of a more strategic approach to transport decisions. In terms of the NZ Transport Agency's six-stage approach to planning, programming and funding (set out in its *Planning, programming and funding manual*), the approach we are proposing could be applied either during Stage 1 (Formulation) or early in Stage 2 (Assessment). Early intervention prior to the detailed EEM process is best way of informing high-level investment and purchasing decisions at an early stage in the development of a project, in order to support a more strategic approach to funding allocation.

Key finding

Overall, we investigated how it might be possible to get a forward-looking view of the productivity and land use changes associated with transformational transport investments. In our view, the retrospective case study approach can be used to provide a predictive tool to assess land use and productivity effects of transformational transport investments. One key factor that enables this is that the tool is intended to be employed at the project inception phase. It is not designed to precisely quantify productivity effects in the same way that agglomeration effects are quantified in the EEM. Instead, it is intended to indicate potential directions of changes to land use and productivity, and through these indications, provide feedback that can be used to better align transport investment with desired land use and economic change – but to do this from an informed perspective, based on what has been observed to happen in similar locations where similar projects have been implemented.

Next steps

The main recommendations are to undertake the following next steps:

- Initiate the implementation of the assessment tool at the strategic planning level within the transport planning and evaluation process.
- Undertake further case studies of transformational transport investments, collecting data over time in order to develop a rich understanding of the local land use and productivity effects they lead to. It is our view that consideration should be given to expanding current transport monitoring and evaluation processes in order to accommodate the data collection required to develop the supporting database.
- Continue with the development of the quantitative (regression) tool in order to expand the analysis from the qualitative starting point to a fully operational qualitative and quantitative assessment tool.

- Encourage other stakeholder organisations to adopt a more strategic approach to project formulation using this type of methodology.

We will further develop these recommendations in conjunction with transport decision makers and other stakeholders as appropriate.

Abstract

The purpose of this research, which was undertaken between July 2010 and June 2011, was to develop, test and recommend additional methodologies that could be used to quantify the economic productivity and land use impacts when assessing transformational or structural transport investments over time. Currently there is a knowledge gap in this area and the intention was to develop a more strategic approach to assist in gaining greater value for money from future transport investments.

We investigated how it might be possible to get a forward-looking view of the productivity and land use changes associated with transformational transport investments. In our view, the retrospective case study approach can be used to provide a predictive tool to assess land use and productivity effects of transformational transport investments.

One key factor that enables this is that the tool is intended to be employed at the project inception phase. It is not designed to precisely quantify productivity effects in the same way that agglomeration effects are quantified in the *Economic evaluation manual*. Instead, it is intended to indicate potential directions of changes to land use and productivity, and through these indications, provide feedback that can be used to better align transport investment with desired land use and economic change, based on what has been observed to happen in similar locations where similar projects have been implemented.

PART 1: RESEARCH CONTEXT

1 Introduction

1.1 Research scope and definition

Currently there is a knowledge gap in the understanding of the relationship between transport investment and returns generated via productivity improvements and changes in land use. Without this knowledge there is no certainty that the 'best' investment decisions are being made by transport infrastructure providers.

The purpose of this research project was to develop, test and recommend additional methodologies that could feasibly be used by transport infrastructure providers to quantify the economic productivity and land use impacts when assessing transformational or structural transport investments over time. We researched the possibility of relating changes in property (or land) values to transformational or structural transport investment over time, and explored how these value changes may be used to identify productivity and land use impacts. The intention was to add to the development of a more strategic approach to funding allocation that would assist transport infrastructure providers in gaining greater value for money from future transport investments. The research project was undertaken between July 2010 and June 2011.

This research purpose was further refined as follows:

- Can we utilise available information on revealed preferences for property to inform the assessment of the productivity[2] and land use effects of transformational/structural[3] transport investment over time?
- Can this be applied by transport infrastructure providers to contribute towards decision making that will deliver greater value for money?

After the first steering group meeting we refined the key output from the project to be 'an economic impact assessment tool or framework that provides a way of evaluating projects *before* they are put through a detailed analysis such as the Economic Evaluation Manual (EEM) process'.

This was seen to be the best approach to enable or support integrated land use and transport planning as an early assessment of a project (prior to a detailed assessment such as the full EEM evaluation) would be more likely to lead to changes in the scope or priority of projects to support better economic and land use outcomes. This approach was therefore consistent with the aim of better integrating transport and land use planning decisions.

2 *Productivity* is defined as the level of value added per unit of resource (economic measures: land, labour and capital) as an output per unit of input. A land use impact is simply the purpose for which the land is used. Transformation refers to a change in the economic productivity of a specific parcel of land.

3 *A transformational transport investment* will be identified on the basis of the outcomes of the project, rather than the cost of project. Transformational projects bring about significant change in economic performance and/or land use, regardless of the scale of financial investment, whereas an expensive project may not be transformational. It is important to identify the location and nature of the economic transformation (eg local, regional, national).

Following the second steering group meeting, the scope of the evaluation methodology was refined further as follows:

- The scope of our analysis would be directed towards the development of a *qualitative assessment tool* that could be applied to projects prior to their passing through the standard EEM procedures.
- The tool could be developed and refined over time, and through this process become more quantitative.

Therefore, our intention was to develop a broad, qualitative impact assessment tool that was able to inform high-level investment and purchasing decisions at an early stage in the development of a project, in order to support a more strategic approach to funding allocation.

After the final steering group meeting, one further clarification on the scope of the tool was added:

- The initial focus would be primarily directed towards investigating the land use effects of transformational transport investments, utilising changes in land use, in conjunction with other indicators, as a way of assessing productivity impacts at the local level.

1.2 Report structure

This report is separated into four parts, with Part 1 forming the introduction and setting the context for the study.

In Part 2 we present a comprehensive literature review, which provides a foundation for the research process and is focused on the following key areas:

- Section 2 – the relationships between transport and productivity
- Section 3 – economic theory as it relates to land valuation methodologies
- Section 4 – land use changes arising from transport investments.

We then use the literature review, in conjunction with feedback and input from the project steering group, to identify and examine useful methodologies and from this, identify a preferred set of tools that can be tested more fully.

- Section 5 includes assessment of empirical evidence elicited from a range of different evaluation techniques, and consideration of the different property valuation assessment techniques, including associated technical issues, strengths and weaknesses, and insights into compatibility issues, methodological issues and opportunities for expanding our knowledge of transport impacts.
- Section 6 includes consideration of the use of alternative land value-based approaches that could be applied to the assessment of productivity and land use impacts of transport investments, and the main findings of the research, setting out an approach for more in-depth analysis.

In Part 3 we undertake the testing of a potential economic impact assessment tool, using a case study to provide data and context. In Part 4 we recommend a way of implementing the assessment tool.

PART 2: LITERATURE REVIEW

2 Transport improvements and productivity: three levels of analysis

The focus of this research was on better understanding the productivity and land use effects of transformational/structural transport investment over time. It is therefore useful to begin with an outline of the understood connections between transport, the economy and productivity. In doing this we note that the assessment of non-transport benefits[4] of transport investments has been undertaken at three different and largely complementary levels that can be categorised as the macro, meso and micro levels. We outline the nature of these three levels and demonstrate that the analysis of impacts on land use and values takes place at the micro level (Banister 2007, p3). This facilitates understanding of the connections between this type of approach and other approaches used to estimate the wider economic benefits of transport projects.

2.1 Relationships between transport and the economy

It is sometimes assumed that investment in transport infrastructure will automatically lead to the promotion of economic development and growth in productivity. However, the literature on this subject paints a more equivocal picture that suggests that although this is plausible, it should not be assumed that such outcomes will automatically occur.

The following two broad camps can be identified in the research literature (discussed in the following subsections):

- Some authors claim that national programmes of public investment, including transport, lead to high rates of social return measured in terms of economic growth and productivity improvement.
- Others claim that such effects may occur but where they do, any contribution to the sustainable rate of economic growth in a mature economy, with well-developed transport systems, is likely to be modest and likely to be influenced by other locational or political factors.

2.2 Macro-level analysis

The key issue underpinning the macro-level analysis is the net effect of transport on the economy. Investigation has focused on quantifying the relationship between economic growth and infrastructure investment.

The earlier literature tends to focus on the presence of historical evidence to claim that investment in transport will make a substantial contribution to economic growth. The main theoretical research supporting this view comprises a number of macro-economic studies focused on the link between public sector investment and productivity growth (eg Aschauer 1989a, 1989b), utilising a production function analysis.

4 Transport benefits relate to factors such as travel, operating cost and accident savings, reductions in emissions or noise, etc. Non-transport benefits relate to the wider effects of transport investment, including productivity and economic growth.

Aschauer argued that public investment in infrastructure leads to increases in firms' profitability, or return on private capital such as the capital invested in a vehicle fleet. Firms respond by increasing the rate of capital investment, leading to higher labour productivity and output, so perpetuating a further virtuous spiral of investment. The result, according to Aschauer, is a return on the public funds invested in public infrastructure that is significantly higher than the return on private capital.

Historical macro-economic data does indeed confirm a close correlation between transport growth, and in particular road transport growth, and economic growth (SACTRA 1999). Critics have, however, pointed out that this data on its own does not help clarify the direction of cause and effect – whether increased movement is a sign of economic growth stimulated by other factors; whether traffic growth, facilitated by transport improvements, itself stimulates economic activity; or whether there is some iteration of the two (ibid).

These studies were initially very influential, due to the strong links identified in early work. However, more recently this approach has been heavily criticised for the following reasons:

- The lack of attention to causality – the approach used does not demonstrate causality but presupposes it (Banister and Berechman 2000). It is pointed out that the empirical evidence used by Aschauer could imply a different relationship of cause and effect – ie higher transport investment not causing economic growth but being made more affordable by growth in income (SACTRA 1999).
- Critics argue that the suggested high rates of return on public capital defy experience – eg the empirical findings of Aschauer in relation to the US do not appear to have been borne out by the UK experience (McKinnon 1996).
- More recent analysis has tended to adopt the view that there is no automatic link between transport investment and economic development for a developed country with a well-developed transport network (such as New Zealand), and where there are benefits, these are likely to be only marginal.

In one influential publication, Banister and Berechman (2000) argued that:

> *In developed countries where there is already a well-connected transportation network of high quality, further investment in that infrastructure will not on its own result in economic growth. Transportation investment acts as a complement to other more important underlying conditions, which must also be met if further economic development is to take place.*

Bannister later said:

> *The key point is that transport investment on its own is not a sufficient condition for economic growth* (2007, p5).

Breheny (1995) similarly argued that roading investment would not necessarily be a sufficient condition for economic growth and might not even be a necessary condition. He concluded that roading investment would only make a significant difference where it was the only missing feature of a strong regional economy. In a depressed regional economy where other conditions for growth were missing, roading investment appears to have made only a limited difference to economic development.

Business and Economic Research Ltd's (BERL) (2011) investigation of the potential economic impact of Auckland's proposed Eastern Corridor supports the approach of Breheny and argues that transport infrastructure will make a positive contribution to economic development if it resolves isolation and bottleneck issues, and if a sound economic basis already exists for growth.

Therefore, when considering how transport investment might stimulate macro-economic development, these studies emphasise the importance of supporting preconditions being present in order for economic development spin-offs to occur from transport investments.

Banister and Berechman (2000) suggested that the necessary conditions relate to economic externalities, investment factors, and political factors, as follows:

- economic conditions – the presence of underlying positive *economic externalities*, such as agglomeration[5] and labour market economies, including the availability of a good-quality (well-trained and highly skilled) labour force, adequate supply of suitable land, etc
- transport investment conditions – including the availability of funds for the investment, the scale of the investment and its location, the network effects (eg are there missing links in the network), and the actual timing of the investment
- political and institutional conditions related to the broader policy environment within which transport decisions must be taken, such as supportive land use planning policies.

They said that individually, these conditions may have very little or no impact on economic development – it is only when all three necessary sets of conditions are present and operating together that economic growth will ensue. Banister and Berechman also argued that transport infrastructure improvements are location related. Thus, they concluded that the identification and measurement of the economic impact of transport improvements must take place at the local level. Aggregating the analysis will fail to capture these local impacts within the analysis.

Other papers support the conclusion that transport improvements, by themselves, are insufficient to ensure economic development. SACTRA's influential report in 1999 concluded that although transport improvements could positively affect economic growth, it is specific local conditions and circumstances that influence the effects of transport improvements, such that no particular outcome can be guaranteed.

In the UK it is assumed that the net effect after allowing for displacement will be zero, meaning that transport investment only has a limited effect on overall economic efficiency and does not lead to growth in GDP or employment (Banister 2007).

The European Conference of Ministers of Transport (2001) found that overall, transport systems improvements could not be said to systematically improve productivity in a region. Improvements to the transport network could increase the pool of available labour, but alternatively, could promote urban sprawl and have little impact where other constraints prevented an uptake of the improvements. It was the form and location of the transport improvement that determined the nature of the outcomes. However, the European Union accepted that the Trans-European Network would positively affect output (raising this by 0.25%) and employment (raising this by 0.11%) over a 25-year period (Oosterhaven and Knaap 2003).

Most recently, macro-level analysis has focused on the use of production function analysis to estimate agglomeration elasticities. This has been undertaken by Graham (2008) in the UK, and Maré and Graham (2009) in New Zealand.

5 Agglomeration is dealt with in detail in the following section.

2.2.1 Summary

The evidence from the macro-level literature suggests that in the case of a region with a developed economy and arguably a substantially complete transport network, investment in transport infrastructure cannot be assumed to automatically lead to economic growth. Rather, the economic growth potential of transport improvements will depend critically on the presence of other preconditions for growth at the national, and most importantly, regional and local level. Specifically, this will be the case where transport improvements can resolve isolation and bottleneck issues, and where a sound economic basis already exists for growth at the local level. More recent developments within the spatial economics literature have done much to provide a framework within which these factors can be analysed. These are discussed below.

2.3 Meso-level analysis: agglomeration – accessibility, density and productivity

Analysis at the meso level is concerned with identifying the wider or non-transport benefits of transport investment at the level of the local economy (Banister 2007). This approach has focused on the benefits of agglomeration, labour market imperfections and network imperfection encapsulated in the concept of wider economic benefits (WEBs).

The growth of urban areas (and New Zealand is one of the world's most urbanised countries) is essentially an economic solution in response to the self-maximising behaviour of firms and workers. But why are cities or urban areas more attractive for the majority of firms and workers? And why do larger cities continue to grow more quickly than smaller ones, even in the face of rising congestion, pollution and other negative externalities?

A key factor underpinning the structural economic transformation and growth of modern cities is the concept of agglomeration – the benefits of higher levels of productivity (and higher returns to businesses and workers) that arise from increasing the concentration of people and economic activity in larger, denser urban areas (Williamson et al 2007). This applies equally to New Zealand cites, as noted by Maré (2008):

> *It is unsurprising that Auckland's productivity and economic performance is higher than elsewhere in New Zealand. There is a clear positive relationship between urban density and good economic performance the world over – a relationship that is captured in the phrase 'agglomeration effects'.*

If agglomeration is so important for the growth of cities, it would be useful to understand the factors that drive this effect.

2.3.1 Sources of agglomeration

Traditionally, agglomeration has been considered in relation to the clustering of manufacturing industries, seen as a market force that makes industries stay in one place to reap the benefits of proximity to labour or raw materials (Manchester Independent Economic Review Secretariat 2010, p5). Agglomeration still has this effect in some sectors, but in the modern, knowledge-based economy, agglomeration has a more dynamic aspect, one that explains the observed urban resurgence and growth (ibid).

The spatial economics literature has made considerable progress in identifying the drivers and quantifying the general importance of agglomeration economies. Rosenthal and Strange (2004) and Graham (2008, pp93-108) both provide reviews of a number of recent studies looking at evidence on the nature and scale of agglomeration economies and the relationship of agglomeration with productivity. This literature emphasises three sources of agglomeration economies, roughly following the examples set out by Marshall (1890):

- **Input-output linkages** promote more efficient provision of intermediate inputs to firms in greater variety and at lower cost – here a 'concentration of producers using particular inputs allows increased specialisation and greater economies of scale in the production of inputs' (Crawford 2006).
- **Larger labour markets** – with increased urban size, deeper labour markets are likely to arise and this 'may allow greater specialisation in human capital, by reducing the risks to workers of firm-specific employment shocks. Similarly it will be easier for firms to find new employees, should current employees quit (Crawford ibid).
- **Technological or knowledge spillovers between firms** – agglomeration facilitates faster communication and transfer of information across firms and other institutions such as universities and research think tanks.

However, as noted in the Manchester Independent Economic Review Secretariat (2010, p6):

> *... despite wide usage, this taxonomy alone is not a particularly useful guide for policy because it is focused on the channels through which we observe the effects of agglomeration rather than the underlying mechanisms that drive the effects.*

In terms of increasing understanding and formulating policy responses, it is important to understand why firms benefit from agglomeration, and then to understand the channels through which this takes place. Duranton and Puga (2001, pp1454-1477) specifically addressed this issue with a classification of mechanisms through which agglomeration economies could occur:

- sharing, which refers to 'indivisible facilities' (eg machinery with high fixed costs that few firms would buy individually); the 'gains from a wider variety of input suppliers that can be sustained by a larger final-goods industry'; the 'gains from the narrower specialisation that can be sustained with larger production; and risks'
- matching, which refers to an ability to improve quality (eg improving the match between the skills demanded by business and the skills available in the workforce) and alleviate 'hold-up problems'
- learning, which refers to the 'generation', 'diffusion' and 'accumulation of knowledge'.

Research indicates that these three mechanisms generate different effects for each of the three sources of agglomeration identified by Marshall, resulting in a wide range of 'welfare and policy implications' (ibid). In a practical sense, agglomeration takes place through features such as the deepening of labour markets, increasing the possibility of skills matching between workers and firms and the increasing demand for labour, encouraging workers to become more specialised. Firms also agglomerate, seeking to reduce risks of contract defaulting, as they have access to a wider set of skills and can establish linkages with suppliers and buyers. Cities are also often places where knowledge spillovers take place, benefiting not only the city but also the wider regional area (Kamal-Chaoui and Robert 2009).

The literature has also focused on the question of whether agglomeration economies arise from 'urbanisation' or 'localisation', the extent to which agglomeration benefits extend across all industries and so depend on overall size (urbanisation economies), or instead only occur within narrowly defined industries (localisation economies) (Manchester Independent Economic Review Secretariat 2010, p29). The former help explain the growth of cities, and the latter the clustering of particular industries and sectors.

At the heart of this process is the modern economy's demand for knowledge (Storper and Venables 2004). The advantage of scale and proximity is that it assists in the sharing and dissemination of knowledge. This mediation of information often requires face-to-face interaction, which is crucial for learning, building trust and reducing risk (ibid). Critically, one study suggested that 'it demands and creates the human relationships necessary for innovation and economic growth' (Manchester Independent Economic Review Secretariat 2010, p5).

There are a number of comprehensive reviews of the empirical literature on the relationship between productivity and urban concentration, such as Moomaw (1983), Gerking (1994), Eberts and McMillen (1999), and Rosenthal and Strange (2004). The most widely cited survey, Rosenthal and Strange (2004), concluded that the consensus view (of elasticities of urban agglomeration) is that doubling urban size increases productivity between 3% and 8%. Most values are under 0.10, which means that at most, a doubling of city size is associated with an increase in productivity of 10% (Manchester Independent Economic Review Secretariat 2010, p5). Rice et al (2006) estimated that doubling the size of a UK city would increase productivity by 3.5%.

A small number of empirical studies have estimated agglomeration effects on productivity in Auckland. Williamson et al (2008a) reported an elasticity of around 0.03 between employment density and average earnings in Auckland, using data from the 2001 census. Williamson et al (2008b) extended this analysis by adjusting for differences in industry and qualification composition of different areas, with a resulting elasticity estimate of 0.099.

Using a different methodology, Maré (2008) examined the relationship in Auckland between employment density and labour productivity, and found a cross-sectional elasticity of 0.09 between area units within the region. Maré found that industry composition differences accounted for about half of Auckland's higher labour productivity across the region. This finding was similar in magnitude to that of Rice and Venables (2004), who attributed around 40% of London's income per-capita premium to job composition. Maré (ibid, p35) concluded that industries were positively selected into Auckland – the industries that were most concentrated in Auckland were the ones that showed the highest Auckland premium.

Maré and Graham (2009, p10) examined agglomeration elasticities across sectors in New Zealand. The paper found that patterns of elasticities by industry were fairly similar to the existing estimates based on UK data. The authors found 'considerable variation in the size of estimated industry-specific agglomeration elasticities'. The largest estimates were for the finance and insurance (0.076), education (0.076), property and business services (0.074), wholesale trade (0.072), and retail trade (0.065) industries. The smallest estimate was for the agriculture, forestry and fishing industry (0.013). This corresponded with the hypothesis that it was the service sector that was most responsive to agglomeration (Melo et al 2009).

2.3.2 Accessibility – key driver of agglomeration

Accessibility plays a critical role in unlocking the benefits of agglomeration and productivity growth in urban areas. To begin with, it is important to clarify the difference between accessibility and vehicle mobility.

The previous Auckland City Council's 'Liveable arterials' plan included recognition that the ultimate role of transport is accessibility, and in particular, the facilitation of the greatest level of social and economic exchange, at all levels of space, within the capacity constraints of the corridor. In this vein, Litman (2010, p4) pointed out that 'mobility is not usually an end in itself, the ultimate goal of most transport is accessibility'.

The development of every city has been shaped, usually in a very significant way, by transport. Importantly, investments that promote a reduction in transport costs can create the opportunity for an increase in the employment density and productivity of a city as 'accessible cities with efficient transport systems have higher productivity than more dispersed places' (Cervero 2000). A paper published by the Centre for Transport Studies in London went so far as to say that 'ultimately transport investment is crucial in sustaining cities and supporting urban agglomeration' (Graham 2005).

A key finding of the Manchester Independent Economic Review, which supported this view, was that 'lowering the costs of living in (or commuting to) high productivity locations is the best way to try to take advantage of spatial differences in productivity' (Manchester Independent Economic Review Secretariat 2010). Venables (2007, p173–188) noted:

> *... there is enough evidence to suggest a positive city size/productivity relationship. The relationship suggests several ways in which a transport improvement might affect productivity. One is that by improving links between firms within the city, the effective density of the cluster rises. The other is that by relaxing constraints on access to the centre, overall city employment is increased.*

An analysis of productivity patterns within Auckland undertaken by Maré (2008) revealed that 'a strong correlation between productivity and employment density' could be observed in the city.

Reducing travel times increases the number of workers who would be potentially available to employers and conversely, brings a greater range of employment opportunities within reach of households. Both of these improve the match between potential workers and employment opportunities, and allow firms to operate more efficiently. Reductions in travel times also allow firms and businesses to interact more effectively between themselves, again improving efficiency and allowing the generation of agglomeration benefits. The following table lists a small selection of studies related to the issue of accessibility and agglomeration in cities.

Table 2.1 Studies examining accessibility and agglomeration

Author	Key finding
GLA Economics (2003)	Statistically significant relationships between accessibility and employment density were found in London.
Bhasin & Buchanan (2007)	Improving accessibility to one of London's most dynamic economic areas produces significant productivity benefits.
Graham (2005)	Increasing accessibility raises effective urban densities, leading to positive gains from agglomeration.
Shefer & Aviram (2005)	Major mass-transit systems generate substantial new traffic flows that enhance agglomeration benefits.

The critical connection between accessibility and economic prosperity arises through the role of urban areas. Donovan et al (2008) identified urban areas as places of exchange, consolidating multiple activities in close proximity and providing greater access to people, goods, and services to facilitate higher levels of economic, social, and cultural activity. Maximising the benefits of exchange is heavily dependent on accessibility in the broadest sense.

At the same time, although exchange opportunities are concentrated in cities, we still need to 'move' to access them, and therefore, cities must also provide space for movement. However, too much 'movement space' limits the amount of 'exchange space', thus defeating the overall purpose of most trips. Donovan et al (ibid) said transport solutions that balanced exchange and movement (access and mobility) and contributed to good urban design outcomes were likely to enhance socio-economic outcomes. From an economic perspective, it is accessibility in its broadest form that we should be interested in.

2.3.3 Summary

At the meso level, investigation has focused on the development of techniques that are able to estimate the non-transport effects of projects on the local economy. The result has been the recent development (including by the NZ Transport Agency (NZTA)) of tools allowing the assessment of agglomeration effects and other wider economic benefits associated with labour market imperfections and network effects.

2.4 Micro-level analysis – impacts on land and property values

At the micro level, the analysis of the wider impacts of transport investments relies on locally specific indicators that offer greater potential to isolate and attribute the effects of transport changes on the level of local economic activity.

The consideration of different analytical approaches undertaken by Banister (2007) found 'it is at the local level that the non-transport benefits can potentially be measured with a reasonable level of confidence'. One reason for this is that it is generally easier to control for many of the wider economic influences at this level of analysis. Similarly, GVA Grimley (2004) found that there could be significant value in undertaking research at the micro level. They concluded 'it is at this level that the local effects of transport investment should be measurable in terms of property and land market effects, and in terms of the environmental and distributional impacts'.

The micro-level investigation of the economic effects of transport improvements has relied heavily on the application of land and property value-based evaluation methods. Thus, we are now able to more clearly locate this study within the range of evaluation tools currently being applied. Although there will inevitably be some overlap and potential for double counting between the wider economic benefits being estimated using meso-level techniques, land values may be better suited to disentangling the complex range of economic relationships and effects that are at play in urban areas, and may therefore provide a more reliable estimate of the real economic impact of a transport investment.

2.5 Key findings and implications for this study

The key observations from the literature relating to transport and economic growth, and which relate directly to this study, are as follows:

1 **Finding:** Investment in transport infrastructure does not automatically lead to economic growth.

Implication: It is wrong to assume that transport investments will always support economic growth.

2 **Finding:** The true economic development potential of transport improvements will depend on the presence of other preconditions for growth (including the presence of underlying positive economic externalities). Where transport improvements can resolve isolation and bottleneck issues and a sound economic basis already exists for growth at the local level, positive effects are most likely to result.

Implication: Different forms of transport investment in different areas will lead to different economic outcomes. We need to consider how to identify both the presence of factors that support economic growth at specific locations and the likely nature and magnitude of the effects generated.

3 **Finding:** The ultimate role of transport is accessibility, not just mobility, and in particular, the facilitation of the greatest level of social and economic exchange.

Implication: Being able to understand the full effects of changes in accessibility (both positive and negative), rather than just changes in levels of mobility, are critical for understanding the real effects of transport projects on economic development.

4 **Finding:** Empirical evidence supports the presence of strong, positive relationships between accessibility and employment density, and employment density and productivity in cities. Productivity patterns within Auckland reveal a strong correlation between productivity and employment density.

Implication: Transport improvements that encourage land use changes supporting higher levels of employment density have the potential to promote productivity growth through the greater concentration of economic activity.

5 **Finding:** Weisbrod (2009) observed that agglomeration benefits are typically capitalised into land values and rents.

Implication: Land values reflect differences in the productivity of land across both space and time.

6 **Finding:** Investigation of the non-transport effects of transport investments, including economic impacts of transport investments, can be undertaken at the macro, meso or micro levels. Whereas the current assessments of wider economic benefits represent meso-level assessments, land or property value analysis takes place at the micro level, providing greater potential to identify clearly at the local level the genuinely additional economic effects of transport investment.

Implication: Land- or property-value analysis can potentially provide a richer and more accurate analysis of the additional local economic effects of transport investments compared with existing evaluation tools.

3 The economic properties of land values

In this section we canvas the key literature relating to the economic properties of land values and their usefulness in understanding the effects of transport projects.

3.1 Rent theory and early developments

Classical economists were well aware that differentials in the productive capacity of land would be reflected in differential rents.[6] Classical rent theory held that the price of land reflected the present value of the stream of rents produced from that piece of land. In equilibrium, rental values would be expected to fully reflect the productivity differentials that existed between different parcels of land (Freeman 1994).

The productivity of land was considered to be influenced by many factors. These included water supply or soil type, and rental values would be expected to take account of and reflect these environmentally determined productivity differentials (Freeman 1994, p368).

Investigation of the relationship between transport accessibility and land values can be traced back to 1826, when von Thunen modelled the relationship between transport costs for different types of agricultural produce and the rental value of agricultural land radiating out from a city. The model implied a clear link between lower transport costs and higher land rents, with agricultural land closer to the centre of the city, with better accessibility to markets, justifying higher rental values (Freeman 1994, p368).

These initial theoretical developments provide the foundations of modern micro-economic research into the effects of externalities on property values.

3.2 Revealed preferences and land values

Land or property values are useful in economic analysis, as they assist in understanding the preferences of individuals for goods or services that are not able to be priced efficiently in competitive markets. Revealed preference techniques attempt to value these non-market effects through establishing a relationship between the particular effect and a related, marketed good (Navrud 1989). To do this it is necessary to identify a marketed good that includes the attribute of the non-market effect, and to isolate this attribute from others affecting the price of the good. In doing this, individuals' preferences can then be revealed via their preferences for the related good or service. The most common examples of revealed preference rely on examining variations in land or property prices.

The analysis of land values has been developed from the simple observation that areas with a high level of amenity are more attractive than similar areas without such amenities. As a result, people are willing to pay more for land or housing in areas with higher levels of amenity. Prices paid for land or properties with differing levels of amenity can therefore 'reveal' the extent of individuals' preferences for these observed differences in amenity.

6 See, for example, Ricardo's *Principles of political economy and taxation,* published in 1817.

Overall, property values can be seen as a reflection of the capitalised valuation of a 'basket' of local factors, including accessibility, safety, noise, visual amenity, community cohesion and business productivity, revealing peoples' actual willingness to pay (WTP) for these services (Forkenbrock et al 2001).

3.3 Land values and the valuation of externalities

One of the most pivotal steps in the development of the application of land or property value techniques in revealed preference studies came through Ridker's (1967) application of property value data in an attempt to estimate the welfare changes to households arising from different levels of air pollution. In this study, Ridker (ibid, p159) hypothesised:

> *... if the land market were to work perfectly, the price of a plot of land would equal the sum of the present discounted streams of benefits and costs derivable from it. ... Since air pollution is specific to locations and the supply of location is fixed, there is less likelihood that the negative effects of pollution can be significantly shifted onto other markets. We should therefore expect to find the majority of effects reflected in this market, and we can measure them by observing associated changes in property values.*

Ridker's research focused attention on three inter-related questions:

1 Do environmental variables (eg pollution or accessibility) influence land values?

2 Is there sufficient knowledge of this relationship to predict changes in land prices associated with changes in environmental variables?

3 Do changes in land values accurately measure underlying welfare changes?

Ridker (ibid) and Ridker and Henning (1967) confirmed the answer to the first question by providing empirical evidence supporting the hypothesis that property values were inversely related to levels of air pollution. The authors also concluded that, in regards to the second question, it was possible to apply the coefficient of the air pollution variable from the regression equation to predict a price change for any residence in respect to a change in air pollution, and that the sum of all changes represented the overall benefit (or change in welfare).

Ridker's initial work stimulated a substantial body of literature examining the observed air pollution–property value relationship. This blossomed into a far broader examination of the relationship between changes in the quality of environmental variables and property values, including the relationship between changes in levels of transport accessibility and changes in welfare, reflected via changes in property values, paving the way for the development of modern hedonic pricing techniques (discussed in section 5 of this report).

3.4 Pros and cons of using land values

3.4.1 Advantages of using land values

An important advantage of using land value (as opposed to other indicators of the value of accessibility change) is that they provide a measure of people's actual WTP for a property with a given set of characteristics, including a given level of accessibility. In contrast, most transport scheme appraisals are

heavily reliant on the outputs from transport models, which in turn rely heavily on estimates of future travel time savings and a hypothetical estimate of the value of this saving, derived using stated preference surveys.

Secondly, most transport evaluation is carried out *ex ante* and is used to determine whether a particular investment is worthwhile. However, there is little attention given to the assessment of outcomes and whether these correspond with expectations, which some authors see as a major weakness of this approach (GVA Grimley 2004).

Thirdly, as observed by Donovan et al (2008), 'land values are already monetised and do not require further processing in order to assign monetary values'.

Finally, land values are also very context-dependent, particularly where analysis is based on property data that is both recent and local. For these reasons Donovan et al (ibid) concluded 'land values are considered to be the most comprehensive and intuitive indicator of good urban design outcomes', which included accessibility outcomes.

3.4.2 Disadvantages of using land values

The main drawback in our situation is that we were wishing to use land values as an *ex ante* indicator and the effects we were interested in would be, in general, a future consequence of the transport investment, and therefore would only be likely to be fully reflected in future prices.

However, as noted in GVA Grimley (2004) '*ex post* evaluation allows a better understanding of the processes at work, and through monitoring it is possible to allow feedback to improve these forecasting methods'. As such, revealed preference techniques utilising land values can be developed to provide a reliable forecasting tool.

3.4.3 A possible evaluation approach

Essentially, we have been considering the potential of obtaining proxy values for accessibility changes from new transport schemes by estimating elsewhere how much residents and/or businesses are willing to pay for similar improvements from existing schemes, which is revealed through variations in the price of land. The transferability of these values, from *ex post* observation to *ex ante* assessment, will determine the success of this approach (Saunders 1998).

According to GVA Grimey (2004, p110), this 'transferability' would be enhanced through the adoption of a number of steps, the first being 'building up a series of internally consistent case studies'. Importantly, the report noted that a 'case study' approach was necessary to understand the complex range of interactions going on at the local level over time.

One important observation made by GVA Grimley that was highly relevant to this study was that case studies are best concentrated on larger-scale projects with limited access points. This is because these examples provide the greatest potential to identify land value uplifts. The scale of change brought about by the project should be assessed by an accessibility assessment.

3.5 Summary and implications

1 **Finding**: Economic theory predicts a positive relationship between improved accessibility, increased productivity and increased land (or property) values.

Implication: The analysis of land (or property) value impacts is particularly useful in understanding the productivity impacts of changes in accessibility, as it captures the localised nature of changes in levels of accessibility.

2 **Finding**: Land values for commercial uses reveal the productive value of a given location and reflect the relative value of a location as 'a place of exchange'.

Implication: The value of adjacent land available for commercial uses can be a good indicator of the effectiveness of a transport solution in promoting accessibility, economic exchange and productivity.

3 **Finding**: The influence of transport on development and land values must always be examined within the context of other major influences, such as the planning framework and market trends, which are also likely to have a strong impact.

Implication: Isolating specific impacts and relating these to changes in values is at the heart of land and property value analysis.

4 **Finding**: Land values reveal individuals' actual WTP for a particular change in the services provided by a location, including accessibility, rather than a hypothetical estimate of value.

Implication: Land values are a reliable way of identifying the actual value that firms or individuals are willing to pay for accessibility improvements in a given location (as opposed to a hypothetical estimate of WTP).

5 **Finding**: The main drawback associated with land values in project appraisal is that the effects we are interested in will only be likely to be *fully* reflected in future prices.

Implication: Land values can be an ideal *ex post* indicator of the real benefits of a project. But for them to be equally useful as an *ex ante* indicator, we need to be confident we can obtain proxy values from observed data. The transferability of changes in land values will determine the success of this approach.

6 **Finding**: *Ex post* evaluation allows a better understanding of the effects of transport schemes. Monitoring allows feedback to improve forecasting methods using land values.

Implication: The development of a useful indicator tool will therefore require a long-term commitment to gathering data from before, during and after projects, to ensure a reliable approach is developed.

7 **Finding**: Transferability will be enhanced through the adoption of a number of steps, the first being the construction of a series of internally consistent case studies. Case studies are best concentrated on larger-scale projects with limited access points, and an accessibility assessment should be undertaken.

Implication: The most likely projects will be passenger transport projects providing significant accessibility improvements at specific nodes, or roading projects with a small number of access/egress points.

4 Transport improvements and land use effects

4.1 Land use and values

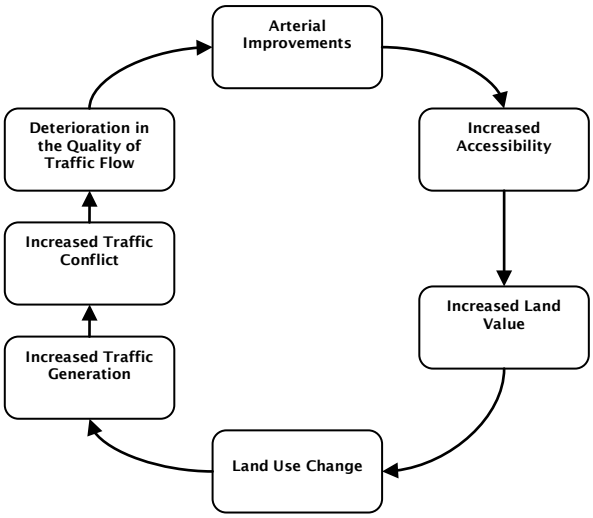
An important component of this study was the consideration of the types of land use changes that could arise from transformational transport investments, and whether information on property values could provide a useful indicator of these changes.

As Forkenbrock et al (2001) noted, land use and property values are closely related, as both reflect changes in the same basic factor – the *demand* for land (including the buildings on it). As a location becomes more desirable (either as a place to live or do business) and more people and/or businesses wish to locate there, then land values will be driven up. Changes in land values might therefore act as a leading indicator of subsequent changes in the intensity of land use.

4.2 The relationship between transport and land use

McGee (2009) stressed the importance of the strong two-way relationship between transport and land use. A transport improvement that increased accessibility to an area was expected to result in an increase in land value, which spurred development but also increased traffic demand to that area, which could then require more transport improvements. Figure 4.1 illustrates this cycle.

Figure 4.1 Transport land use cycle (Stover and Koepke 2002, p3)



Although McGee's comprehensive study found comparatively little research into the specific relationships between transportation improvements and new development or redevelopment, this was still considered to be an important effect of transport improvements. In support of this view, a recent European study found that all transport investment projects examined resulted in investments in urban development, redevelopment and renewal of space. The amount of investment varied according to factors such as development potential, access to new land or a brownfield site, and market pressures (relative scarcity) (Gospodini 2005). Intuitively, this would be as expected, with transport a key shaper of urban form.

In the same way that the economic development outcomes associated with a transport investment will be largely determined by other supporting factors or preconditions, so the nature of the land use changes will also be strongly influenced by the economic, social and spatial characteristics of the project area. Work undertaken by Adams and VanDrasek (2007) found that the following factors would be expected to strongly influence the scale and nature of the effects of transport investment on land use:

- the nature of the area surrounding the project, including:
  - available undeveloped land or land ready for redevelopment
  - appropriate access
  - directions of patron traffic to associated businesses
- the characteristics of the area, especially:
  - the population and economic growth rates of the metropolitan area
  - the current trends and conditions in local land prices and development densities
  - the centrality (link to other destinations in the transportation system) of the project.

Gospodini (2005) added the following factors to this list:

- condition of the built environment in the corridor area
- existing demand for new space and accommodation of new land uses
- local economic situation – if there is a dramatic shift in the general economic conditions, the effects of the transportation investment on urban development, redevelopment, and regeneration cannot be accurately estimated.

4.3 Time lag associated with economic development and land use impacts

It is important to take into account the time that will be required for transport improvements to be fully realised into land values and consequently the time that may be required to exert the full influence on land use.

On the one hand, the effects of transport projects are only realised over time, often over many years or decades. A study by Alam et al (2005) showed that the lag of benefits from transport projects in the US can extend from 2–25 years. The study considered that post-construction medium-term benefits (including increased retailing and movement of the workforce) occur up to 10 years later and usually within 6–8 years. Long-term benefits (including new industry development) occur within 25 years, and usually between 15 and 20 years.

However, set against this is the observation that the benefits of a transport investment can be at least partly capitalised into land values earlier than they are actually realised. This is consistent with the way in which financial instruments, such as shares, reflect the capitalised value of future earnings. In the extreme, land values can be observed to respond positively to planning decisions, even well before the construction of the project has commenced. In a recent study conducted in Auckland, Grimes and Young

(2010) found that land prices adjacent to stations on the Western Rail Line rose by 8.5% in response to the announcement of the double-tracking of the rail corridor.

As noted in GVA Grimley (2004, p110):

> *What is more important in the context of land value change is the acceptance that these variations take place over time and there are differential effects on existing and new developments.*

Also, the timing of land value uplift may well differ between modes. Observations appear to indicate that roading schemes are likely to initiate a response in property values earlier than passenger transport schemes. This may be connected with a perception that roading schemes are more certain to progress than passenger transport projects. It may also reflect developers' preferences, with roading projects being perceived as having a higher probability of providing benefits to residents or businesses. A number of UK studies referred to in the following section note that changes in land values adjacent to new passenger transport projects appear to have taken place between two and five years after completion of the schemes, with little variation noticed until the schemes had become fully operational and well established (RICS Policy Unit 2002). There is also reason to believe that rail schemes can elicit a greater response than bus schemes, as rail is seen as being a more permanent investment than bus services, which may be more likely to be removed or reduced in the future.

4.4 Business location drivers

Research undertaken on the relationship between transport provision and choices of business (Steer Davies Gleave 2007) and household (David Simmonds Consultancy 2007) location provides a helpful perspective for this study.

4.4.1 International research examples

Steer Davies Gleave's (2007) study of business location in the UK examined the factors influencing the choice of business location and related these to transport. The evidence from surveys and other related studies (McQuaid et al 2004) identified a range of factors including:

- the quality and scope of the physical and business infrastructure
- factor cost and supply, especially labour
- market demand and links to international markets
- institutional infrastructure and networks
- a culture supporting 'civicness' and entrepreneurship
- indigenous company growth
- agglomeration economies
- technology development
- social factors such as climate, lifestyle, image and crime rates.

McQuaid et al (2004) noted that these factors do not relate directly to transport, but transport does contribute to a number of these. The conclusion reached by Steer Davies Gleave (2007) was that rather than using transport directly as an influencing factor on business location, it was more important to focus on how transport affects the factors that then influence business location decisions. The study concluded that the primary factors contributing to the ability of a location to attract businesses would be:

- the availability of suitable premises
- access to a suitable workforce
- access to customers and suppliers.

An earlier study by Gordon and McCann (2000) found a similar pattern, noting that access to the national road network (54% of respondents), cost of premises (31%), availability of skilled labour (29%), proximity to customers (28%) and good rail connections (28%) were key factors in business location choices.

4.4.2 Location of firms in Auckland

A recent report prepared for the Ministry of Economic Development examined the reasons why firms choose to locate in the Auckland region (Miller et al 2011). A key finding was that location does matter for firms and there are business-related drivers for firms to be located in Auckland, as opposed to other locations within New Zealand.

Positive features that attract firms to Auckland and then retain them there include:

- access to a larger pool of highly qualified specialists, as well as to skilled, unskilled and casual labour
- better connectivity to regional and international markets as well as supply chains
- access to a larger customer base
- stronger potential to attract international corporate visitors
- easier to attract and retain skilled labour from overseas.

Negative factors that might lead to a firm leaving Auckland include:

- costs involved in dealing with local authority regulations (eg zoning and consents)
- traffic congestion
- the higher costs of doing business in Auckland compared with other parts of New Zealand.

Firms observed that it is 'a double-edged sword' being located in Auckland, because the cost of living, employees' salary expectations, and labour costs are higher in Auckland compared with other parts of New Zealand.

These are not surprising results and are quite consistent with much of the work on the economics of urban areas, but they are a useful confirmation, from the individual firm's perspective, of the theoretical underpinnings of agglomeration and of the relative benefits that transport accessibility can confer on a specific location.

4.4.3 Summary

The relevance of these findings to our study is clear. Where transport investment leads to an improvement in one or more of these factors, it will be expected to increase demand for the given location (as the economic potential of that land will be improved) and therefore positively influence land prices. The reason for this will be the assumption by firms that this location now offers the opportunity for increased productivity and profit. Therefore the rise in land values will be reflective of the additional productivity derived from the improvement in the transport-related factors driving the locational choices of firms.

For example, improved access to a skilled workforce provides better opportunities to match the requirements of a given task with the skills of workers, leading to a more productive workforce. So, if (as an extreme example) a new transport connection resulted in a suburb of Wellington becoming as accessible to workers as the CBD, this would be expected to increase the attractiveness of the suburb as a business location, thus increasing land values.

4.5 Summary and implications

1 **Finding**: Land use and property values are closely related, as both reflect changes in the same basic factor – the *demand* for land.

Implication: Land values are a price signal and can act as an indicator of land use change as firms and residents respond to these signals.

2 **Finding:** European research found transport investment projects resulted in investments in urban development, redevelopment, and renewal of space. However, the amount of investment varied according to factors such as development potential, access to new land or a brownfield site, and market pressures (relative scarcity).

Implication: Local factors will strongly influence land use changes.

3 **Finding**: The benefits of transport investments are likely to be capitalised into land values earlier than they are fully realised.

Implication: Land values can provide an indication of the stream of future benefits from a transport investment.

4 **Finding**: The timing of land value uplift may well differ between modes. For passenger transport projects in particular, there may be a lag between the development of a project and the capitalisation of benefits into land values.

Implication: Collecting data from before, during and after completion of a project (quite possibly a number of years) will be necessary to ensure all benefits are being fully captured in land values.

5 **Finding:** Where transport investment supports the factors driving a firm's location choice, it will be expected to increase demand for the given location.

Implication: Therefore, understanding the drivers of the location of firms will assist in the development of a qualitative and quantitative assessment framework.

PART 2 (cont): ASSESSMENT OF METHODOLOGIES

5 Empirical evidence and methodologies

To begin, we consider the empirical evidence pertaining to the theoretically positive relationship between transport improvements and land values. In doing this we examine the techniques used to elicit these values. A wide range of tools are available for estimating changes in land values arising from transport schemes, ranging from sophisticated hedonic pricing and other regression-based models to simpler descriptive methods and property value comparisons. These methods are now commonly used to estimate the economic benefits or costs associated with factors such as:

- environmental quality, including air pollution, water pollution, noise and severance
- environmental amenities such as views, urban design features, proximity to recreational sites, and safety.

In this section we focus on regression and hedonic pricing models. In the following sections we extend the analysis to descriptive and comparative methods. We focus on the opportunities and issues associated with these tools and how these relate to our objectives.

5.1 Empirical evidence

The empirical evidence illustrating the observed relationships between property values and transport improvements is vast, with literally hundreds of papers, articles and books devoted to the subject. Many studies concentrate on identifying the property value impacts associated with major passenger transport schemes, and good summaries of the literature (primarily relating to passenger transport) can be found in both GVA Grimley (2004) and RICS Policy Unit (2002). A number of these studies went beyond pure mobility considerations and adopted an approach that considered the whole travel chain, from origin to destination, which is consistent with our broader definition of accessibility.

A simplifying generalisation is that the literature can be divided into two geographically distinct groups, motivated by two particular sets of circumstances:

- North American research has largely focused on investigating the relationship between investment in public transport and property values in order to justify public funding for transit schemes.
- UK research is motivated more by an interest in the possibility of capturing the uplift in property values associated with public transport investments, as a supplement to public funding.

5.2 North American research

North American research (which began in earnest in the 1990s) focused mainly on investigating the empirical relationship between investment in public transport (often rail-based mass-transit schemes), and commercial and residential property values. An important rationale for this work was that no robust analytical framework existed to assess the potential benefits that might be generated from the substantial investment required to develop mass-transit schemes.

A notable observation from a snapshot of studies is the consistently positive relationship observed between the transport improvement being examined and the chosen property value indicator.[7] Ryan (1999) undertook a comprehensive review of empirical studies of the relationship between roads, heavy rail, and light rail-transit systems and property values over a 40-year period, and concurred that there was evidence of some considerable variability in results. Ryan (ibid) went on to develop an explanation for the inconsistent results presented in the literature. The study found one important difference related to whether travel time or travel distance was used as a measure of accessibility – when access was measured in terms of travel time, study results usually indicated the expected relationship, with reduced travel time positively influencing property values. When studies used travel distance as a measure of access, results tended to show mixed property value effects. RICS Policy Unit (2002) also considered this issue and concluded that the variability in (positive) impact pointed towards three possible explanations: the importance of other factors, the specificity of the results, or the limitations of the methods used.

Importantly, Ryan (1999, p423) concluded '... it is likely that the value of the properties where residents or firms are located will be bid up if travel time savings accrue to residents or firms'. Therefore, a property or land market response could be expected in cases where a transport intervention promoted changes in travel times. However, these studies concentrated heavily on mobility, with Ryan's identification of the importance of travel time confirming that property values were being related to the motorised part of a trip rather than the complete journey from origin to destination, which would be required to determine a relationship with accessibility. The narrow focus on mobility and motorised trips may lead to a situation that justifies certain types of travel behaviour, but by overlooking broader measures of accessibility, actually undermines this objective.

Methodologically, North American studies are characterised by the almost exclusive use of hedonic pricing models.

5.3 UK research

The second group of studies were generally undertaken in the UK from the late 1990s onwards. The catalyst was a growing interest in the possibility of capturing the uplift in property values associated with transport investments as a means of funding major urban passenger transport schemes. The most popular area of interest appears to be the impact of rail-based passenger transport improvements on residential property values (see appendix table A.2 for a summary of key studies).

The main observation from the UK studies that we examined is that the results reported are somewhat less conclusive on the positive relationship between accessibility and property values, as compared with the North American studies.

7 However, it is important to note that this consistency masks substantial variability in the magnitude of the positive effects recorded. For example, whilst Cervero and Duncan (2002) observed a $25/sq ft premium for office space within 400m of a station in Santa Clara, California, Sedway Group (1999) observed a $74/sq ft premium for commercial land prices in San Francisco within 400m of a BART station. It should also be noted that an analysis by Du and Mulley (2006) found that 'most of literature on this topic tends to concentrate on the positive side of the results but taking a closer look shows considerable variation in the findings'. The authors noted that because different approaches had been taken, the results were not comparable in terms of the unit of values used.

Du and Mulley (2007a) undertook a comprehensive comparative analysis of the results of a broad sample of UK and US studies and found a notable lack of statistically significant results for UK studies, in contrast with US studies. For example, the Jubilee Line Extension (JLE) study failed to identify any significant effect in Phase 1 (Chesterton 2002) using a hedonic price model, and this was substituted by the adoption of an 'agents survey' in Phase 2 (Pharoah 2002). Although this latter demonstrated positive results, the methodology was not as robust.

An important development that has arisen from the UK research is a greater focus on the overall trip from origin to destination, including walking time, thus recognising the need to capture accessibility effects rather than just mobility. The study undertaken by Du and Mulley (2006, p26) examining property price impacts associated with proximity to the Tyne and Wear Metro included allowances for walking times to and from stations. The study found clear evidence of a price premium for houses located within 1km of metro stations. However, the study also found that being within 200m of a station gave a negative premium for one area. This area had the highest rate of unemployment in the region, suggesting that other external factors can be important determinants of property prices.

5.4 Reliability: issues of data availability and quality

Generally speaking, the empirical evidence derived from many studies tends to conform with theoretical expectations. A positive relationship is generally observed between land or property values and transport improvements that provide greater levels of mobility or accessibility. However, the considerable variability in results gives rise to some concerns around the reliability of estimates.

Bannister and Thurstain-Goodwin (2005) observed that the quality and availability of data from North America is good. This in turn allows the use of more sophisticated methods, including regression analysis and specialised hedonic pricing models.

The evidence from the UK and Europe, where there seems to be less time-series or repeated cross-sectional data available for analysis, is more varied. It was also suggested by Du and Mulley (2006) that the insignificant results observed in the UK might relate to difficulties of data acquisition because property transaction data was not open to researchers, although Bannister and Thurstain-Goodwin (2005) noted there was reasonable quality data from the HM Land Registry, the Valuation Office and other agencies covering the residential sector (Du and Mulley 2006).

Data availability (or lack of it) has resulted in a wider range of methodological approaches being applied in the UK than in the US, and the greater use of more simple indicators in some UK studies, such as transactional price analysis, growth assessment and projected rateable values. This contrasts with the strong and almost exclusive reliance in the US on hedonic pricing techniques.

In New Zealand, Quotable Value New Zealand (QVNZ) maintains a comprehensive property database, with selling prices of properties and a broad array of characteristics for those properties. It also contains meshblock[8] references for each property. However, although the sale price for the property is the market price, the land value is the valuation of the land component of a property, not the actual market price of the land.

8 The meshblock is the smallest geographic unit for which statistical data is collected and processed by Statistics New Zealand (see www2.stats.govt.nz/domino/external/omni/omni.nsf/wwwglsry/meshblock).

A further important issue is that the hedonic pricing and regression modelling approaches are reasonably complex and tend to be very data-intensive. This often makes them time-consuming and expensive to develop. Thought therefore needs to be given to the extent this technique may be applied to individual projects, and whether a more economical indicator approach can be developed and applied as a forecasting tool, based on parameters observed from a small number of case studies (possibly using hedonic or regression models).

5.5 Reliability: the important distinction between global and local estimates

The focus in the UK on the potential for capturing land value uplift as a funding stream raises the issue of the reliability of global (aggregated) estimates of property value changes compared with localised effects. The intention to consider seeking payments from beneficiaries of transport schemes necessitated developing a much clearer picture of who (or which localities) would gain (or lose), and by how much, as a result of a transport intervention. This is clearly much more important when seeking actual contributions from beneficiaries, rather than simply estimating global values.

Du and Mulley (2006) hypothesised that the use of global statistics fails to provide a useful insight into changes in land values and can actually lead to misleading results in the examination of spatial relationships. For example, they noted that global statistics for England may show that the age of houses does not significantly affect house prices. But in some parts of England, old houses, such as those built in Victorian times, might have character, thus generating higher prices than newer houses in the same area. However in other urban areas, older houses built to lower standards to house workers in rapidly expanding cities in the 1850s might be in poor condition, resulting in substantially lower prices than newer houses. This means that using a set of local statistics, in which data is analysed at the local level, is necessary to provide more accurate results in a study linking house prices to accessibility.

The importance of localised effects is demonstrated in a number of studies that have identified inconsistent results between different areas in the relationship between transport accessibility and land value. For example, in a study undertaken in Atlanta (Cervero and Landis 1995), proximity to rail had a positive effect on house prices on the south side where neighbourhoods were dominated by higher-income groups, and negative effects on the north side where neighbourhoods were dominated by lower-income groups. Conversely, many studies demonstrate that proximity to a major road will reduce property values due to the effects of traffic noise, pollution and severance. This builds on the earlier literature focused on the external costs of transport.

In examining the extent of the spread of property value impacts, Diaz (1999) found that pedestrian accessibility to stations was an important determinant of a project's effect on property values. The study found that:

> *... the positive effects of rail transit on property values were most prominently felt within a very limited distance from transit stations. This distance is determined by the distance of a reasonable walk from the station, generally one-quarter mile to one-half mile. Beyond this zone, the effect of the proximity to rail on property values is negligible* (Diaz ibid, p4)

An important conclusion reached by Diaz (ibid, p4) was that easier vehicle access to stations had limited appreciable effects on property values, and this 'highlights the importance of creating more pedestrian connections to rail transit stations and enhancing the pedestrian environment around stations'. The State

of California also conducted a number of pieces of research that demonstrated the economic benefits of walkability being reflected in positive changes in property values (Local Government Commission for the California Department of Health Services 1998).

Slightly further afield, Munoz-Raskin (2006) examined the relationship of bus rapid transit and residential property values within walking distance of the system in Bogota. The results showed that values were greater for properties in immediate walking proximity of feeder lines, and that middle-income properties were valued more if they fell closer to the system, while there were opposite results for low-income housing. A temporal analysis found a slight average annual increase in property values correlated with the implementation of the system in two areas.

As a result of research into localised effects, the following two major methodological advances have been made, designed to directly address the question of the reliability of the empirical relationships observed:

- the development of a broader assessment framework using both qualitative and quantitative methods
- an extension of the hedonic pricing model, notably the use of geographically weighed regression (GWR) techniques.

The next section considers these advances more fully.

5.6 Attribution

A key consideration is the correct attribution of impacts. It is important to ensure that any assessment of property values is placed within a wider context to capture the effects of other factors on land prices. GVA Grimley (2004) observed that similar transport investments could be expected to deliver different outcomes in different locations, due to differences in local economic conditions. These differences will need to be understood and catered for in any analysis that attempts to attribute benefits from an *ex post* evaluation of one project to an *ex ante* assessment of a new scheme.

To ensure that the uniqueness of each location is identified, described and recorded, it will be useful to consider the importance of factors such as:

- market conditions
- proximity to the labour pool
- locational constraints (eg zoning)
- quality factors (including image, environmental quality and amenity).

5.7 Recent developments in improving the reliability of property value estimates

Overall, reliability would appear to be the critical issue in the application of property valuation-type approaches. The recent work undertaken in the UK has led to six key conclusions and associated actions that can support improved reliability in studies of changes in property values (see table 5.1).

Table 5.1 Improving the reliability of empirical estimates of property value changes[a]

Attribute	Description
Location	Every study is unique and the effects of accessibility changes are not uniform. A broad approach to investigation is appropriate, covering the whole of the area under study.
Time	The treatment of time is important. Ideally, data should be available from at least four points in time: before the decision to build is taken; prior to opening; immediately after opening; and downstream.
Catchment areas	The impact area for residential developments appears to be wider than those for commercial developments. Evidence indicates that depending on the investment, residential impacts could extend to 1000m, whilst those for commercial developments are likely to be concentrated in an 800m radius (GVA Grimley 2004).
Scale of investment	GVA Grimley (ibid) found that for passenger transport schemes, measurable impacts were more likely to be found where there were substantial improvements in accessibility and there were discrete stations or stops around which impacts could be studied. Consequently, most of the research has concentrated on large-scale urban rail systems, which offer the best opportunities to test for the property market effects.
Attribution of impacts	The contextual situation is important and should be used as an input to any analysis. Value uplift has tended to be looked at in a rather narrow way, mainly through changes in property values. Where possible, a wider range of measures should be used.
Methodology	Hedonic pricing (HP) is the generally preferred approach adopted to identify and isolate the property market effects. The geographically weighted regression (GWR) technique is more spatially sensitive and accounts for local variations, including access to schools, employment and socio-economic conditions.

a) Table is sourced from material contained in Banister and Thurstain-Goodwin (2005) and GVA Grimley (2004).

GVA Grimley (2004) noted that although regression and hedonic pricing are the most appropriate methods for estimating changes in land values 'the levels of explanation are still modest (up to 50%)'. The conclusion was that there was also a need for more contextual analysis and the establishment of simpler indicators that would cover both transport and non-transport effects. These are developed more in section 6.3 of this report. From these elements of change, it was then considered possible to establish a series of quantitative relationships, as outlined in table 5.2.

Table 5.2 Relationships to analyse

Quantitative relationships
Correlations between location and price (land value and rents)
Correlations in the changes in land prices and accessibility (on an area-wide basis)
Regression on the price of land (or rents) by public transport (or other transport). Would expect location choice to be positively related to availability of land and accessibility.
Regression to test whether new build is positively related to changes in accessibility, and the amount of vacant land is negatively related to accessibility.

The statistical results will then need matching and comparing with qualitative information and data to assist in better understanding the realities of the statistical relationships identified. Again, section 6.3 considers this point in more detail.

5.8 Technical considerations associated with hedonic pricing models

It is obvious that hedonic pricing models are both a popular and useful tool. Nevertheless, the literature confirms that hedonic regression models are subject to a number of quite complex technical considerations. As documented by Suriatini (2006) and Donovan et al (2008), these issues include multi-collinearity, heteroscedasticity and autocorrelation.

Multicollinearity is where two or more independent variables included in a regression model are highly correlated. Where multi-collinearity affects two or more variables, the results of hedonic regression models are less stable. This affects the stability of individual coefficients. Where multi-collinearity is detected, it may be treated by dropping one of the correlated variables and/or expanding the sample size. Heteroscedasticity invalidates some of the basic assumptions underlying the use of regression models, but it can be corrected for – eg by using additional explanatory variables. Autocorrelation describes covariation within an independent variable in a regression model. It is common in variables that exist in close proximity (spatial or temporal), and it is not necessarily a bad thing. The existence of unexplained autocorrelation suggests that there are additional variables, not included in the model, which are relevant to predicting land values.

Overall, it was concluded by Donovan et al (2008) that although hedonic regression models were subject to certain technical challenges, statistical tests and modelling techniques were available to identify, and potentially correct, for many of these challenges. On the other hand, Donovan et al (2008) observed that these limitations should be viewed in the context of existing indicators and models (specifically travel-time savings and speed-capacity models), for which post-implementation validation studies (particularly the link to socio-economic benefits) are tentative at best. In this context, the technical issues associated with hedonic regression models appear to be manageable.

5.9 Summary

1 **Finding:** The empirical evidence derived from many studies tends to conform with theoretical expectations, with a positive relationship generally observed between land or property values and transport improvements that provide greater levels of mobility or accessibility. However, the considerable variability in results gives rise to some concerns around the reliability of estimates.

   Implication: Understanding the reasons for the variability in the results will help us to form a view on the appropriateness of data-transfer techniques.

2 **Finding**: Whereas earlier studies concentrated on identifying global property value impacts associated with changes in mobility, more recent developments have led to an increasing focus on demonstrating the more localised impacts of accessibility improvements.

   Implication: These estimates reveal a high level of local variability in land values following a transport improvement, indicating the importance of other local factors.

3 **Finding**: An important advance has been the combination of quantitative and qualitative information, providing a significantly richer picture of the effects of transport changes on property values.

Implication: This directly addresses the question of the reliability of the empirical relationships observed, and provides a way of better understanding the localised impacts of transport improvements on property values.

4 **Finding**: For regression and hedonic pricing, the levels of explanation are still modest (up to 50%) (GVA Grimley 2004).

Implication: There is also a need for more contextual analysis and the establishment of simpler indicators that would cover both transport and non-transport effects.

5 **Finding**: The statistical results will need matching and comparing with qualitative information and data to assist in better understanding the realities of the statistical relationships identified.

Implication: A combined quantitative and qualitative analysis provides the greatest potential for understanding the complex relationships and the attribution of cause and effect over time.

6 **Finding:** An important observation of the methods reviewed here is that they were not used to distinguish between the specific productivity benefits of transport improvements and the overall accessibility benefits of the scheme. They were used to assist in revealing changes in land use. This is an important finding for our study, as productivity effects are a central area of interest. It does not mean that we can't elicit such values, but it does confirm that this has not been a specific area of focus of previous studies.

Implication: On a more positive note, a way forward is to consider the application of a combined quantitative and qualitative analysis as a way of dealing with this, using observed changes in land use to assist in revealing productivity effects.

6 Comparative and descriptive techniques

Building on the findings from section 5, we now examine a selection of comparative and descriptive approaches that provide a more qualitative assessment of the responses of land or property values to a transport improvement. We look in particular at how approaches might be usefully applied to the question of revealing productivity and land use effects.

6.1 Market studies

This approach has been used primarily to assess changes in values of commercial property, either as a unique study or as part of a wider package of investigations (eg Forkenbrock et al 2001, Chesterton 2002). It involves the estimation of accessibility changes on business costs and profitability.

1 The first step is to develop a profile of the types of land use and commercial business activity occurring in an area that could be affected by the proposed transport investment.

2 Then an estimate is made of the extent to which the proposed investment would be expected to affect pedestrian, car and public transport access to the area. For this analysis it is necessary to determine the extent to which specific types of businesses are sensitive to changes in accessibility.

3 Step three involves determining how the accessibility changes would affect the relative cost of doing business in the affected area, and the effect on revenue. The results are translated into estimates of the annual change in business revenue in the affected area and the discounted present value of that additional revenue stream. This value, when expressed on an area basis, is considered to represent the incremental effect of the proposed investment on the capitalised value of surrounding land and building space.

According to Forkenbrock et al (2001), this approach is most suitable for application in cases where retail and service businesses are dominant, as these activities require access to a surrounding residential or business-oriented customer base.

An important issue to bear in mind when considering applying this approach is the considerable uncertainty in forecasts of business performance – this method can only be expected to provide a rough order-of-magnitude estimate of benefits to businesses.

6.2 Comparable valuations approach

This approach has generally been used to estimate changes of residential property values. Comparable valuations rely on estimating the value of a transport investment in one area by examining how property values vary among locations in and near similar areas that already have such a transport attribute. The method relies on comparing current property values among different locations rather than looking back in time. This approach is also described as a 'static comparison' (Forkenbrock et al 2001, p166).

Therefore, this method only works if comparable situations exist in the local area. This location should also share land use and socio-economic characteristics with the area around the proposed investment. It should be within the same general area (city or region) as the proposed project location, to ensure that the areas share the same regional economy, labour market, development industry and zoning policies.

To apply this technique, information is required on market rents and current property prices for locations at varying distances from the chosen comparable transport facility. From this information, a rent or price gradient is then calculated. This will reveal information on the variations in existing property values associated with proximity to (or distance from) the existing facility. From this information, estimations can then be made about the likely effects in property values that could be experienced around the proposed project site.[9]

An important issue with this approach is that appropriate comparable locations are often not available. Also, even when they do exist, they are often less-than-perfect matches to the proposed project and setting. In this case, findings derived from price gradients would need to be adjusted to account for the differences between the two areas. It is necessary to determine whether the location of the proposed new investment has unique characteristics that would increase or reduce the property value effects of the project relative to those found in the comparison area.

Studies suggest that this method has limited applicability and is appropriate only if:

- there are similar transport facilities already existing elsewhere in the local area
- the nature of those facilities and the neighbourhood(s) surrounding them, including characteristics of accessibility, noise, visual quality, community cohesion and business productivity, are comparable with the proposed new facilities and the locations surrounding them.[10]

6.3 Case studies

The case study method (as used, for example, by Forkenbrock at al (2001)) is really just an extension of the comparables method, but examining a wider geographic area and allowing for a longer time frame. It may be a useful approach where a comparative tool is deemed appropriate but there are no useable local comparables to rely on.

This method tends to rely on the analysis of a single case study area where a similar project was implemented. It derives estimates of effects by comparing 'before' and 'after' conditions, generating a time series comparison. These effects can then be used to estimate outcomes for the new project.

The approach requires identification of similar types of projects in other areas and information regarding the nature of subsequent changes in surrounding property values and intensity of land development following the completion of those projects.

9 This gradient in theory represents the combined market valuation of accessibility, noise, visual quality, community cohesion, and business productivity effects. It should be interpreted as reflecting the degree to which property values increase or decrease with proximity to transportation facilities similar to those being proposed.

10 Example (Forkenbrock et al 2001): Property owners whose homes are near, but not adjacent to, a proposed new highway interchange are worried that the project would reduce their property values. Analysis is conducted of property values in a roughly similar type of neighborhood elsewhere in the city where there is an already existing highway interchange. It is found that property values in the comparable area currently rise with proximity to the interchange, as long as they do not actually abut it. The finding from the comparable situation is that proximity to an interchange does not necessarily reduce property values in the given type of neighborhood being studied.

The results can show which areas, streets and groups of people around the existing transportation project experienced property value changes. GIS maps can be used to illustrate the locations and magnitudes of property value changes. However, this method can have limitations. Notably, it relies on very similar settings or regression to distil applicable conclusions.[11]

At the more applied level, GVA Grimley (2004) noted that as regression and hedonic pricing provide only modest explanatory power, there is also a need for more contextual analysis and the establishment of simpler indicators that would cover both transport and non-transport effects. These could include travel times, accessibility levels, rent levels, land values, ownership patterns, and land availability. To monitor these factors, GVA Grimley compiled a list of 'indicators of change' as set out in the table below:

Table 6.1 Indicators of change

Key indicators
New business and residential locations – movers in and out
Benefits to existing residents and businesses – capital uplift
Land price and rental levels and changes
Changing patterns of land ownership, with consolidation of sites for development
Investment yields on existing commercial property
Accessibility levels and changes (ie travel time changes)
Land availability and vacant land (and buildings)
Development starts and consent applications

The critical point being put forward by GVA Grimley was that 'the quantitative analysis is being used to inform the qualitative analysis, which in turn feeds back into unravelling the relationships between land values and transport'. This combined approach is seen to provide the greatest potential for understanding the complex relationships and the attribution of cause and effect over time.

Chesterton's (2002) qualitative methodology drew on media reports, research reports and property agents' perspectives. Residential and commercial property values were sourced from valuation records. A key observation about this approach is that care must be taken, as land values will vary according to types of development (or zoning) and these factors must be controlled for in the analysis.

6.4 Descriptive statistics and transactional analysis

This method relies on the development of cross-sectional descriptive statistics in order to initiate the development of a set of time series data that can then be used to assist in attributing cause and effect from transport investments. As an example, Chesterton (2002) used a descriptive statistical approach to assess the impact of the Jubilee Line Extension on land values.

11 Example (Forkenbrock et al 2001): In a comparable community, it was found that property values decreased 1% for each 100 additional average vehicles per day on residential streets. Assuming that similar effects would occur near the project in question, reducing traffic from 1000 to 600 vehicles per day on a particular residential street would be predicted to increase property values by 4%. If there are 500 residential properties along that street with an average value of $100,000 each, the project can be predicted to increase total property values by $2 million (500 x $100,000 x 4%).

The analysis covered:

- property market impacts
- rent levels
- land values
- ownership patterns
- land availability.

Qualitative analysis relied on data from other research reports, property agents' perceptions gathered via questionnaires, and media information.

The advantage of this approach was that it allowed a picture to be built up of what was actually happening in response to the project through the examination of statistical relationships in the cross-section data (eg correlation analysis). This also required a series of indicators of 'change over time' to be developed to monitor these factors over time.

Transactional analysis is identified as a stand-alone approach by some authors, but is essentially a subcomponent of a descriptive statistics approach. This approach monitors changes in property and land values, using observed data. The only major concern is that the reliability of the analysis is dependent on the quality of data available. Data availability in New Zealand is good, with property prices recorded by the real estate industry, although QVNZ land values are based on valuations by experts rather than market transactions. This data would be the primary input into any hedonic pricing model.

6.5 Projected rateable values and growth assessment

This approach relies on expert determination of property market changes including prices, demand and yields. It is entirely dependent on the expert's knowledge and ability to accurately forecast changes, and so is limited in terms of reliability, but it can be a useful comparator to assist in assembling qualitative and quantitative information (GVA Grimley 2004). It should be noted that the land value component of the QVNZ dataset is an estimation provided by an expert valuer, and this data has been deemed by Grimes and Liang (2008) to be sufficiently rigorous to apply to studies in New Zealand.

6.6 Summary

Clearly there is no single tool or methodology that is able to provide a complete analysis and is without weaknesses or drawbacks. The market studies approach would be useful in compact business areas, but is more difficult to apply to broader study areas and residential locations. The comparables approach is potentially quite rigorous – however, it is limited by the difficulty in finding sufficiently closely matching locations to use as the comparator.

A case study approach offers the possibility of a useable tool, if we are able to identify sufficiently generic comparator projects that can be defined as being 'transformational' and that can then be used to provide an information base against which proposed projects could be compared.

In particular, it is felt that this would be strengthened by using the types of indicators and the descriptive statistics identified above as a starting point, prior to the development of a more sophisticated quantitative model that would then form a further component of the assessment tool.

It is this approach we have developed further in the next section of the report. A key issue that we addressed is the way in which we identify the projects that will form the basis of the case study and collect the necessary data, in order to maximise the potential to reliably transfer this data to other project applications.

7 Relevant local research

7.1 Urban form, transport and land value

At the time of undertaking this project, BERL (2011) were also undertaking complementary research to identify observed relationships and/or inter-relationships between variables such as urban form, in particular urban density; industry profile of businesses and employment; transport mode usage; and attractiveness of the location as revealed in land values. BERL was moving from studying empirical observations to studies that generated some identifiable relationships between and among these main variables. One of these studies was a component in a Foundation for Research, Science and Technology (FoRST)-funded three-year project headed by Opus Central Laboratories on 'Transport, energy and urban form – the future' (in progress). The approach looks at the possibility of relating changes in property values to transformational/structural transport investment over time, and from these value changes, identifying productivity and land use impacts.

To date, BERL's analyses indicate a number of promising results that point to sound and predictable relationships between and among a number of these key variables. They indicate that land values, and therefore WTP for accessibility and other qualities, are likely to be reflected in land values, and that these are likely to be able to be expressed in predictable relationships.

Most of the relationships explored indicate that there may well be some variables omitted from the models specified. More research will be needed, probably on purposive subsamples of Census Area Units (CAUs), and/or more finely defined areas in meshblocks.

BERL found that by analysing land values in CAUs across urban New Zealand (1054 CAUs) at the censuses 1996, 2001 and 2006, strong relationships were obtained that explained the value of land per hectare, either as residential land or as commercial/industrial land. Each CAU was classified as predominantly residential, or predominantly commercial/industrial. The values at this initial high-level stage were not site-specific.

7.1.1 Residential land values

For the CAUs classified as residential, by far the strongest explanatory variables for land values were:

1 the population density (resident people per hectare)

2 the mean personal income in the CAU.

The percentage of residents who used public transport (PT) in their travel-to-work journey also showed some significance in the econometric analysis, but was not as significant as the other two. The percentage PT use variable had a coefficient with a negative sign, which is counterintuitive.

The relationship between percentage PT use and land value is important because the level of PT use presumably reflects accessibility, which we would expect *a priori* to be a determinant of land value, all things being equal. This is discussed further below.

The relationships between land value and residential density, personal incomes and percentage PT use described a consistent level of about 50% of the variance in the CAU land values in each of the three

census datasets. This implies that a substantial share of the variance may be explained by variables omitted from this specification. As we discuss below, this could include PT supply variables.

7.1.2 Commercial/industrial land values

For the CAUs classified as commercial/industrial, by far the strongest explanatory variable for land values was the workplace employment density per hectare in the CAU. The broad parameters of the industry profile of employment in the CAU also explained some of the variance, but at a lower level of significance than the employment density per hectare. The percentage of the employees employed in the business services industries had a significant and positive impact on land value per hectare, and the percentage of the employees employed in the social services industries had a significant and negative impact on average land values in the CAU.

The positive impact on land values per hectare of the share of employees in business services is to be expected because these services require a good level of accessibility for their clients. The labour productivity per employee in most business services is higher than the average in other industries, and so this impact on land values is reflecting the higher level of productivity per employee and (taking account of the employment density variable) per hectare.

The higher land values are expressing the landowners' WTP for land in the higher-density areas, land that is suitable for locating business services organisations.

The negative impact of the share of employees in social services could well be largely arithmetic. This is because most employers of large numbers of workers in social services (schools, hospitals and the like) occupy extensive sites, and these land areas will tend to 'dilute' the average land value in the CAU where they are located, below the level that would be expected otherwise.

The relationships between land value and employment density per hectare, and the respective shares of employment that were in business services and social services, described a consistent level of 86–92% of the variance in the CAU land values in each of the three census datasets.

7.1.3 Relevance to our question

A paraphrase of our question is: Is the relative level of accessibility reflected in the WTP for land, ie the observed land value?

A higher level of residential density, and in most cases of employment density, will reflect a higher level of accessibility to urban services, etc. The highly statistically significant relationship identified between residential density and land values indicates that we can infer an impact of a transport investment on the level of residential density that can be expected to occur, and we could also project an expected increase in land value. This is, of course, an *ex ante* projection of value, so is little more defensible than an *ex ante* projection of benefits to transport improvements estimated by the EEM system.

However, if we are able to observe an increase in land value associated with an increase in residential density *ex post*, and stimulated by a transport investment (associated with a facilitating zoning change), then we can be confident that future similar transport investments associated with a facilitating zoning change will result in the expected increase in land value.

These observed, identifiable relationships explaining land values can now be tested by applying them to past projects that have now reached a new 'equilibrium' of land use, urban density and land value.

7.1.4 PT use, urban size and other variables

Initial research investigated relationships between urban form and PT use. Note that as this was using census data, the PT use variable was the percentage of the travel-to-work journeys that residents made by public transport (or passenger transport) on census day. This found a strong relationship between percentage PT use and the size of the urban centre where the residents lived. This could well be because there was no variable specified that reflected the PT supply frequency, quality, etc. It is to be expected that PT supply would be greater in the larger urban centres.

The second aspect of accessibility and PT use is that PT use has complementary/competitive relationships with the use of active modes (AM), especially in areas close to the urban centres.

A third aspect of PT use is that all things being equal, PT use is found to be higher for CAUs of residents with higher incomes than for CAUs of residents with lower incomes.

7.1.5 PT use and land values

Given the third factor above, namely that PT use is higher in higher-income CAUs than in lower-income CAUs, it is counterintuitive to find that in our multiple regression models to explain land values, the percentage PT use in a CAU has a coefficient that is quite large and is negative. This implies that in CAUs with percentage PT use that is high, the land value is lower than in those CAUs where PT use is low.

This contradicts the findings related to PT use alone, where higher PT use is found in CAUs with higher incomes. (The areas with higher incomes would be expected to have higher land values.)

Further exploration of the datasets is now underway and it appears that these PT coefficients may be driven by outlier observations, particularly in higher-density more-recently settled areas, where the density has driven the land values higher but there is, as yet, very little PT supply, and so the percentage of PT usage is very low.

7.1.6 Findings relevant to our study

There is sufficient evidence of sound, identifiable relationships to indicate that it should be possible to specify models that will explain differences in land values in terms of variables that reflect accessibility, land use and productivity.

There are indications in some relationships of the apparent existence of omitted variables, and the existence of different relationships at different stages of ‘maturing’ of urban development. This means that by studying some case studies of changes over time, we may well be able to have some confidence in the level of change in land values that will be stimulated by transport investments. This will presumably require that such transport investments are implemented together with associated facilitating changes in zoning to encourage higher-productivity land uses.

In other words, transport investments are a component of integrated urban developments such as transit-oriented developments (TODs).

7.2 Property value effects associated with extending Auckland's northern motorway

Grimes and Liang (2008) estimated the benefit arising from the extension of Auckland's Northern Motorway from Greville Rd in Albany to Silverdale. They found that population and employment rose substantially in locations near new exits and to the north of the motorway extension, relative to developments elsewhere on the North Shore and in the broader Auckland Region (Grimes and Liang 2008). The modelling results also showed that land values rose strongly near new exits, and that the gross benefit of the extensions of the Northern Motorway from Tristram Ave to Orewa was at least $2.3 billion.

The estimates took into account the possibility of diminution in value occurring elsewhere near the existing Northern Motorway network, but did not include any benefits that may arise in commercial property values in the CBD (and elsewhere) from increased accessibility to an enlarged labour pool (Grimes and Liang 2008).

Interestingly, this is one of the few studies to consider the benefits of a significant roading project. Also interestingly, the methodology is a development of earlier work by Haughwout (2002), which considered the value of infrastructure investments rather than actual changes in accessibility brought about by the infrastructure.

8 Summary of previous research

The information above provides some useful insights into the use of land or property values as a means of understanding the likely impacts of transport investments on productivity and land use. Here we briefly summarise the important advantages and disadvantages of land or property value techniques, and consider how these may influence the design of an economic impact assessment tool.

8.1 Advantages

1 **The relationship between accessibility, productivity and land values:**
Economic theory predicts a positive relationship between improved accessibility and increased productivity, and between increased productivity and increased land (or property) values. These relationships can be expected to be positive with respect to an improvement in accessibility.

Land values for commercial uses reveal the productive value of a given location. In an economic sense they reflect the relative value of a location as 'a place of exchange'. Therefore, the value of adjacent land available for commercial uses can be a good indicator of the effectiveness of a transport solution in promoting accessibility, economic exchange and productivity. As Weisbrod (2009) observed, 'agglomeration benefits are expected to be capitalised into land values and rents'.

For residential properties, land values will partly reflect the ability of people in the area to access employment opportunities. Differences in residential land values will be expected to reflect differences in the productivity (or rather earnings potential*)* of employment locations that are accessible by people in different residential locations. Improving access to more productive areas will be expected to increase the demand for residential accommodation in a given area and therefore, the value of the land in that area.

2 **Capturing the benefits of accessibility:**
Accessible cities with efficient transport systems have higher productivity than more-dispersed places (Graham 2005), with accessibility promoting higher employment densities and in turn, productivity increases. Thus, improving accessibility is a key driver of the benefits of agglomeration through the potential for a greater concentration of economic activity.

However, project appraisal techniques that value only the benefits associated with the motorised parts of trips (through travel time savings) consequently favour improvements that affect these parts of a journey.

Conversely, approaches that consider changes in land values allow for a broader assessment of effects, including the benefits of changes in levels of accessibility.

The analysis of land (or property) value impacts is particularly useful because it demonstrates the localised nature of some accessibility impacts, and because it confirms the actual value that firms or individuals are willing to pay for accessibility improvements in the market (as opposed to a hypothetical estimate of WTP).

Overall, from a productivity perspective, land values are likely to provide a more complete estimate of benefit within local areas.

3 **Actual WTP and *ex post* assessment:**
Land values have a distinct advantage in that they reflect the actual price individuals or companies are willing to pay to secure a particular location. All other assessment tools rely on estimations of WTP, such as hypothetical values of time applied to travel time savings.

Most studies of the land value impacts of transport investments focus on the assessment of post-project effects, in contrast to the assessment of future benefits used in project evaluation. This provides a good evidence base of the scale, distribution and drivers of actual land value impacts.

4 **Timing of effects:**
Although the effects of transport projects are only realised over time (often over many years), the benefits of a transport investment may be capitalised into land values earlier than they are actually realised. In the extreme, land values can be observed to respond positively to planning decisions, well before even the construction of the project has commenced.

5 **Data availability:**
As well as observed prices, property transactions data is widely available from QVNZ. Although the database on land values is not comprehensive, the data does provide a substantial amount of supporting information on property attributes (eg view from property, etc) that can be used to help isolate the effects of accessibility on property values.

6 **Wider influences:**
The influence of transport on development and land values must always be examined within the context of other potential effects, such as the planning framework and market trends, both of which are also likely to have a strong impact. Isolating specific impacts and relating these to changes in values is a key part of the application of land and property value analysis.

8.2 Disadvantages

The main disadvantages or issues identified include:

1 **Forecasting using *ex post* data:**
A major concern with the use of land values is that we are interested in a forward-looking tool that is capable of performing an *ex ante* assessment of a project's effect on land values. However, hedonic pricing techniques requires *ex post* data on observed changes in property values. Two of the methods covered in section 6 address this concern, but rely on the transfer of data from observations of actual projects to forecast the effects of a yet-to-be-implemented project.

2 **Geographical coverage:**
Whereas transport models can provide a regional view of the effects of a project, land value analysis tends to be more geographically limited, although it provides a richer picture. Care must be taken to ensure coverage is sufficient to capture network effects, including both the origins and destinations of journeys.

3 **Variability of effects:**
Whilst most studies confirm the existence of a positive relationship between transport improvements that lead to improved access or mobility and property value, more recent developments focusing on the more localised impacts of accessibility improvements tend to reveal a higher level of variability in their results. The importance of localised effects is demonstrated in a number of studies that have

identified inconsistent results between different areas in the relationship between transport accessibility and land value.

4 **Isolating productivity impacts:**
A key question is whether it is possible to reliably distinguish productivity impacts from other determinants of land values. There is some conjecture on this point. Whilst some authors (eg Gibbons and Overman 2009) believe reliable estimates of productivity will not be forthcoming from land values, others are more optimistic. For example, Forkenbrock et al (2001, p159) noted that:

> *... changes in property values are driven by, and hence mirror, the value associated with local changes in accessibility, safety, noise, visual amenity, community cohesion, and business productivity. In general, a transportation project would only lead to changes in property values (and in subsequent land use) if it caused a direct change in one or more of these other local factors.*

The key issue is whether it is possible to reliably ascribe a change in property value to a productivity gain resulting from a transport improvement. There is no doubt that this is not easy to do. However, the work being undertaken by BERL (2011) at the time we were completing this research, which is covered in section 12, provides a way forward here.

8.3 Overall conclusions from the literature review and assessment of methodologies

We identified that land values are a good *ex post* indicator of the effects of transport investments, including the effect on the productivity of a site, and that land values can also be useful indicators of future land use. The next key challenge was to develop an impact assessment tool that could use information on observed changes in land values to predict how future land values might change in relation to changes in accessibility that occur with transport investments.

Our objectives (as set out in the introduction) were to develop and test an economic impact assessment tool or framework, focusing on the development of a qualitative assessment tool that:

- provides a way of evaluating projects before being put through the EEM process
- can be developed and refined over time and through this process, become more quantitative.

Therefore, our intention was to initially develop a broad, qualitative tool to inform project assessments and higher-level investment and purchasing decisions, and support a more strategic approach to funding allocation. Based on the evidence we reviewed, this approach appeared to be logically sound.

Whilst hedonic pricing and regression models can provide a useful tool to analyse *ex post* changes in land and property price data at the local level, and offer the potential to disentangle the effect of different factors on land or property prices, these models can also lack explanatory power at the local level. One recent way of enhancing these models has been through the introduction of a spatial element, often via a GIS model, which can be incorporated to provide more locally specific estimates.

At a technical level, reliability and data requirements would appear to be the main issues surrounding the application of property valuation-type approaches to estimating the benefits of accessibility improvements. At a practical level, a challenge is to convert an *ex post* analysis of observed responses to past projects into a useful *ex ante* economic impact and land use assessment for proposed projects.

The recent development of much broader assessment frameworks with a strong reliance on qualitative assessment methods to identify localised impacts has offered the opportunity of providing a significantly richer picture of the effects of transport changes on property values and land use at the local level.

In particular, the finding in section 6.3, that a case study approach using indicators and descriptive statistics as a starting point prior to the development of a more sophisticated quantitative model would be useful approach to test further, was consistent with this thinking. This would conceivably allow us to transfer observed information from case study projects to new situations where projects were proposed.

Overall, our main conclusions to this point were as follows:

- The development of this assessment tool needed to be seen as a long-term process, with sensible staging to allow time to refine the approach and collect the necessary data.
- The logical starting point was to begin with the development of a mainly qualitative assessment tool, based on a checklist or indicator type of assessment including descriptive statistical analysis. This would involve the development of a set of economic impact assessment (EIA) criteria, with a checklist of indicators and quantification of effects where possible.
- This would allow a more quantified approach, utilising hedonic or regression-type modelling, to be added on over time.
- The intention was to support the incremental enhancement of information over time to allow increased quantification as more data is collected, particularly via post-project evaluations. A long-term view is vital for this process to be successful.

Therefore, it was proposed that the best way to progress was through the development of an approach that could rely on the observation of qualitative indicators, but could be developed to become more quantitative over time as more observational data was collected. This staged development would allow the gradual refinement and quantification of the evaluation tool. The implication was that over time there would be the need to construct a regression-type approach, but starting with the development of a qualitative and descriptive tool would be useful in the short term and would then provide the richness needed to accompany a regression-based quantitative analysis. A key issue would be the ways in which we collected data and the potential to reliably transfer this data to other project applications.

The preferred methodology was a case study approach, using qualitative indicators and descriptive statistics, as a starting point prior to the development of a more sophisticated and complementary quantitative model.

PART 3: DEVELOPING AND TESTING THE CASE STUDY APPROACH

9 Introduction and approach to case studies

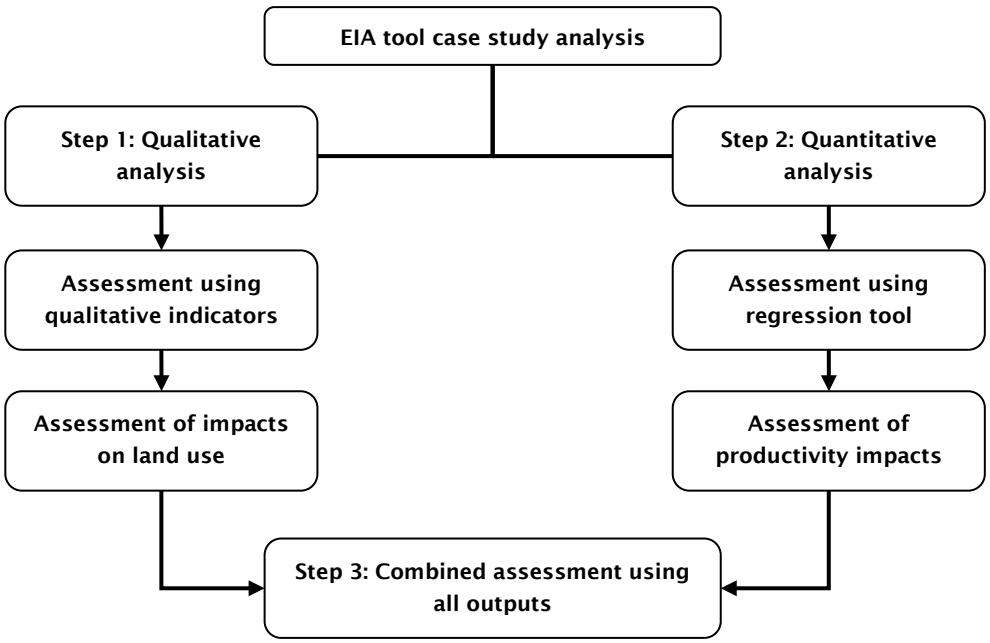
Through the top-down literature review and analysis of both theory and practice, we identified an approach that could theoretically be used to measure the magnitude of productivity and land use impacts of transformational transport investment on property values. The next step was to develop and test key elements of the approach.

9.1 Approach to testing

Overall, our assessment considered the extent to which a case study-type approach, focusing on land values and a range of additional indicators, could be used to accurately assess the productivity benefits and potential land use impacts arising as a consequence of transformational transport investments. A key issue was to comment on the potential for the impact assessment tool to lead to an improvement in value for money from transport investment.

We noted that in our process of developing this tool with the steering group, there was an understanding that the qualitative tool would first be more capable of providing insights into land use effects, which could then be further interpreted to assist in revealing productivity effects. The quantitative regression tool would be a key instrument in the more rigorous assessment of productivity changes. A diagrammatic summary of the proposed approach is provided in figure 9.1 below.

Figure 9.1 Three-step case study assessment process



The following chapters apply the first step in the process and examine the strengths and weaknesses of the approach, and include consideration of:

- the extent to which drivers of changes in land values can be accurately identified
- the extent to which values can be attributed to the specific effects of transport investments
- the translation of changes in land values into effects on land use patterns, or vice versa.

The approach to the development of step 2 is then addressed in chapter 12.

9.2 Attributes to be addressed

The following table sets out the specific attributes of the approach we were looking to develop, as derived from the key observations and findings of the literature review (particularly from GVA Grimley 2004), insights from the steering group, and the practical application of this type of approach.

Table 9.1 Key attributes

High-level consideration	Disaggregated attributes
Timing of effects	Treatment of time – ability to capture effects before, during and after construction
	Ability to be applied ex ante
Attribution of effects	Extent to which drivers of changes in land values can be accurately identified and quantified
	Ability to account for other contextual variables that may impact upon the land values
	Extent to which values can be attributed to the specific effects of transport investments
Ability to be applied to location	Adequate catchment area
Cost and complexity	Ability to use existing data
	Ability to use quantitative and qualitative information
	Ability to develop to become more forward-looking over time
Reliability	Ability to translate changes in land values into effects on land use patterns
	Ability to reliably transfer data to other project applications

In section 9.1 we use these considerations, in conjunction with the four main conclusions from section 8, to assist in understanding the performance of the case study approach being investigated.

9.3 The prevalence of transformational projects

The key purpose of this tool is to utilise existing evidence as a basis for estimating productivity and land use effects of future projects. Principally we were interested in understanding the productivity and land use effects of transformational transport investments. We defined this as a being contingent on changes in accessibility, not simply scheme cost or scale. An important question to consider, given the relatively small size of New Zealand, was how many transformational transport projects were actually likely to exist,

firstly to warrant the application of this approach and secondly to enable case studies to be undertaken and a database to be constructed.

As noted earlier, the question of whether a project is determined to be a transformational transport investment is more appropriately addressed on the basis of the outcomes the project promotes, rather than the scale or cost of project. Transformational projects are deemed to be those that bring about (or are expected to be capable of bringing about) significant changes in land use and economic performance, regardless of the scale of financial investment, whereas an expensive project may not necessarily be transformational. There is no exact measure that can be used to determine precisely whether a project is appropriately defined as transformational. The literature does, however, provide some useful guidelines around the types and locations of projects that are likely to influence land values and land use in a way that is readily observable, and this may help in determining the scope of application.

Firstly, when assessing the potential to capture meaningful differences in land values as a result of a project, GVA Grimley (2004) found that measurable impacts for passenger transport projects are likely to be found 'where there is a substantial improvement in accessibility and where there are discrete stops or stations around which land value changes can be observed'. This actually indicates a fairly broad level of applicability, as most rail and bus investments are predicated on a substantial improvement in accessibility and are served by discrete stops or stations. In a New Zealand context, urban rail upgrades or bus infrastructure developments and associated service-level changes, which provide additional capacity and/or accessibility to new or existing stops and stations, fit within this description. Specific projects could include the new rail link to Onehunga, the Northern Busway (and its extension to Orewa), a major urban bus priority scheme, or a new transport interchange. These are fairly common and are all likely to promote some form of transformation of land use and economic activity. Therefore, application to passenger transport projects is likely to be fairly straightforward for projects in urban areas.

For roading projects GVA Grimley (2004) suggested that 'larger scale motorway projects and limited access roads would have greater accessibility impacts and concentrate land value changes at intersections'. However, this seems a little narrow and overlooks other potentially important factors, such as connecting an area with development potential into an existing network. A good example of this type of project would be Highbrook Drive and the motorway interchange connecting the Highbrook Business Park with State Highway 1 in Auckland. As noted by McConnell Funds Ltd (2010), the result of the development 'saw a relatively remote and low-profile property holding of some 192ha of equine and pastoral land use *transform* (emphasis added) in value to a fully consented commercial property with direct access to Auckland's southern motorway'. McConnell Funds Ltd also noted that Highbrook Development Ltd:

> *... was instrumental in creating the third route into east Auckland with the construction of a new $70 million motorway interchange leading into Highbrook Drive. An agreement was reached which saw Transit NZ and Manukau City Council as the primary sponsors in its construction. Highbrook Drive was built by HDL and vested to Manukau City Council in return for the building of the interchange. This arrangement created huge exposure for the business park in the form of circa 40,000 vehicles per day along Highbrook Drive.*

So, in the eyes of the developer, a $70 million scheme was clearly quite transformational.

RICS Policy Unit (2004) concluded that 'a step change in accessibility was needed before a significant increase in property value occurred'. Unfortunately, 'step change' was not defined any more precisely and is left open to interpretation or reflection from the results of any assessment. However, the above example

suggests that providing accessibility for 40,000 vehicles per day would be easily sufficient to be deemed transformational in Auckland.

One other way of assessing whether a project is likely to be transformational is through the justification provided by the project proponents themselves, where the rationale for the project includes the desire to promote economic and/or land use transformation. Overall, there are likely to be many projects that can appropriately be deemed transformational. The following key attributes or criteria can help to determine whether a project has transformational potential:

- Passenger transport infrastructure or services providing additional capacity, and/or a new station, stop or interchange that has the potential to provide a substantial improvement in accessibility – there is no specific definition of this accessibility change, but Auckland Transport classifies the Rapid Transit Network (RTN) as a passenger transport system with a high-frequency, high-quality service operating on 'transport spines', which does not get held up by road traffic congestion. These are likely to link into an area of existing or potential intensified commercial or residential or commercial/industrial development.
- Roading that is designed as limited access, and/or provides a connection to a strategic network, and/or serves an area of existing or potential intensified commercial or residential or commercial/industrial development, and/or carries over 30,000 vehicles per day.

A selective list of planned and existing Auckland projects that have the potential to fit within the scope of a transformational scheme are listed in the table below.

Table 9.2 Selective list of transformational Auckland projects

Existing projects (implemented 2000–2010)	Future projects
Britomart Transport Interchange	CBD Rail Loop
New Lynn Interchange	Airport PT Link
North Shore Busway	Waterview Connection
Onehunga Branch Line	PENLINK
Manukau Rail Link	Second harbour crossing
ALPURT B1 and B2	North Shore Busway Extension
SH20–SH1 Connection	Mill Road
Hobsonville Extension	AMETI
Highbrook Drive	North Shore Rail Extension

Although New Zealand is a small country, there is really no shortage of schemes that have transformational potential. This is not surprising, given that transport is an enabler of development and has the potential to lead patterns of growth and land use change. The real issue may, in fact, be more related to the timing of investment. Where investment is lagging and growth and expansion of the transport network is being undertaken in a reactive way, one argument suggests that investment is accepting the existing pattern of growth and simply locking this in – in a sense, transformation has already taken place and the best that can be done is to allow this land use to function better. But even here, there is the strong possibility that transport improvements will increase the attractiveness of the areas served for further development and the result may encourage land use change and transformation. Leading this change still requires an understanding of how transport and land use will interact. This is essentially what we are proposing with this approach.

9.3.1 Defining 'transformational'

From a process perspective, our recommendation is that judgement should be used to determine whether a project can be considered transformational. This judgement can be structured around the following questions:

1 Passenger transport projects:

- Is there, or will there be, the potential for a substantial improvement in accessibility?
- Are there discrete stops or stations around which land value changes can be observed?
- Does the project serve an area (or areas) of high population density (existing or planned)?
- Does the project serve an area (or areas) of existing or future commercial and or/industrial activity?

2 Roading projects:

- Is the project a motorway of larger-scale scheme with limited intersections?
- Does the scheme connect an area with development potential into an existing network?
- Does the project serve an area (or areas) of high population density (existing or planned)?
- Does the project serve an area (or areas) of existing or future commercial and or/industrial activity?

9.4 Scenario for testing purposes

To test the methodology, we needed to assume an example of a potential future project. The example chosen was the development of a new motorway interchange on an urban fringe, which was assumed to have the potential to be transformational on the surrounding area through being an intersection on a major, limited-access road that served an area designated for residential and commercial/industrial intensification.

10 Building up the case study tool

The key features of the case study tool are that it:

- can rely on the analysis of a single or multiple case studies where a similar project was implemented – transferability of data to the new situation is the key requirement
- derives estimates of effects by comparing 'before' and 'after' conditions, generating a time series comparison, which allows a picture to be built up of what was actually happening in response to the project over time
- can provide information regarding the nature of changes in surrounding land use following the announcement, building and completion of projects
- can be applied to new projects as they are progressing through the formulation stage, so that early monitoring can be undertaken as well as assessment of land use and productivity effects.

The general structure of the approach we are developing is similar to that recommended by GVA Grimley (2004). A strength of this methodology is that it meets our requirements of a qualitative tool that can be extended to become more quantitative over time, and also that it allows for interpretation of evidence in addition to more formal analysis.

The approach is based on the key steps set out in the table below.

Table 10.1 Key steps in the complete analysis

Part 1: Qualitative analysis
• **Approach:** Qualitative and descriptive assessment of land use changes and productivity effects • **Method:** Assessment using case study(ies) • **Indicators:** Land values, land uses, population, dwellings, employment, firms, traffic counts, planning and zoning information
Outcome: Qualitative, contextually rich description of the observed land use and productivity effects of the case study project(s) at the micro (local) level
▼
Part 2: Quantitative analysis
• **Approach:** Quantitative assessment of changes in land values arising from the case study project • **Method:** Regression analysis of observed land values sourced from QVNZ database • **Indicators:** Changes in land values with respect to coefficients
Outcome: A quantitative analysis of the response of land values within the case study area
▼
Part 3: Combined analysis
• **Approach**: Combines the outcomes from Parts 1 and 2 to provide a quantitative analysis that is informed by the contextual and qualitative findings from Part 1
Outcome: A comprehensive, rigorous and contextually rich understanding of the land use and productivity changes within the case study area

A key point to bear in mind is that this approach is essentially reliant on historical data. One important outcome we would hope to achieve is the development of a framework that can be populated through the monitoring of project impacts before, during and after construction. The purpose of this is not to question the effectiveness of investment decisions or to audit projects, but to use actual, observed effects on land values and land use to better inform future project-investment decisions. The lack of observable evidence from past projects is a major gap in this process.

10.1 Qualitative indicators and descriptive statistics

The qualitative component of the case study tool should be based on the development of a set of discrete indicators and descriptive statistics derived from secondary sources.

These will establish a contextual background to the analysis by giving insights into what is taking place in the locations under examination and also in the economy more generally. They should be developed and added to over time to become more quantitative, and to increase the richness and potential accuracy of the analysis, whilst recognising that useful insights can be gained from undertaking a qualitative analysis in the short term.

The descriptive statistics and qualitative information and associated data sources that should be used are as follows:

Descriptive statistics:

- land and property prices over time (ideally from pre-construction to 5+ years of operation) at the local level and regionally for comparison
- land use patterns from ownership information
- commercial and industrial property rental levels and changes over time at the local level, and regionally to supplement land prices if deemed useful
- local retail turnover data in areas where retail activity is strong
- accessibility and transport trends locally in the study area
- employment and firm data to plot changes in economic structure (eg composition of employment by sector), level of employment and how this compares with changes across wider region
- change in population and key socio-economic indicators such as employment status, income, education, etc.

Qualitative information:

- general commercial property market trends such as ownership patterns, movements in and out of business locations, and property agent's perspectives
- trends in residential property eg increases in housing stock
- land availability and vacant land (and buildings) and consolidation of sites for development
- proposals for changes of land use and development/redevelopment opportunities around the assessment area

- zoning information
- social conditions, deprivation levels etc around the assessment area
- proximity to public facilities and/or open space (often seen as too complicated).

Sources of data:

- land and property values sourced from QVNZ
- SNZ employment data (census and annual)
- SNZ business unit data (census and annual)
- SNZ income data (census and annual)
- transport data from monitoring (vehicle counts etc)
- a site visit (recommended).

This information can be used to develop a comprehensive profile of the study area over time, illustrating changes in land values, land use, economic structure and potentially productivity. The qualitative analysis should follow the steps set out below.

Table 10.2 Key steps in Part 1 – Qualitative analysis

Step 1: Identify appropriate case study project/area(s)
▼
Step 2: Develop baseline profile of case study area prior to case study project
▼
Step 3: Establish planning context/zonings applying to the case study area
▼
Step 4: Analyse travel patterns and accessibility
▼
Step 5: Examine residential land use, population and dwellings changes over time (census data)
▼
Step 6: Ascertain land use changes over time, using property database
▼
Step 7: Examine changes in economic structure over time, using employment and firm data
▼
Step 8: Examine land value and productivity changes over time, property database and census income data
▼
Step 9: Consider relationships with wider geographical area
▼
Step 10: Outcomes: land use and productivity effects

10.2 Combining quantitative and qualitative analysis

The constraints of the project did not allow us to fully develop a quantitative tool as part of the methodology. Instead we utilised complementary research to provide an outline of an initial regression tool that was able to identify productivity effects of passenger transport improvements. We provide more detail on this model in section 12.

The key step in completing the evaluation process is to combine the results of the qualitative and quantitative analysis in order to provide a rigorous analysis that is able to be interpreted at the local level. This is important, as differences at the local level are likely to strongly influence land use and productivity effects of transport projects.

11 Case study: Silverdale Motorway Interchange

11.1 Introduction

The key purpose of this step in our research was to ascertain how the case study approach might be applied in practice.

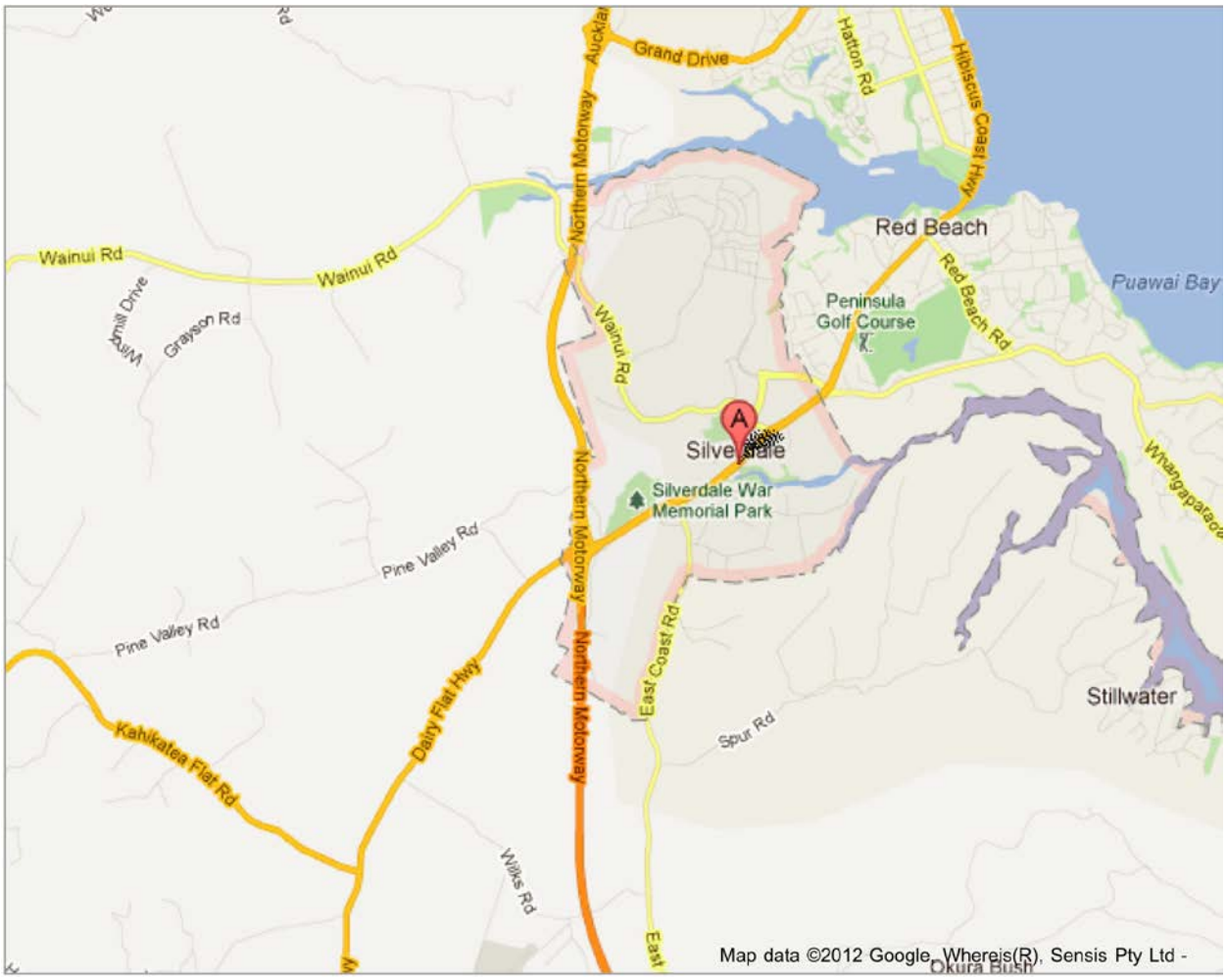
11.2 Step 1: Case study selection and description

We selected the Silverdale Motorway Interchange, north of Auckland, to use as the case study, as this was an example of a new motorway interchange on the urban fringe, consistent with our hypothetical project.

The interchange is located south-west of Silverdale at the point where State Highway 1 crosses State Highway 17, approximately 35km north of Auckland's CBD. The interchange was a component of ALPURT A, the extension of the Northern Motorway from Greville Rd, Albany to Grand Drive, Orewa. Construction began in 1997 and the project was completed in 2000.

It was considered reasonable to use the interchange as a case study in isolation from the complete motorway extension project, as the local effects would conceivably be similar whether the interchange was provided at the inception of the project or as a discrete addition at a later date.

Figure 11.1 Map of case study area



11.2.1 Relevance of this case study

The previous Rodney District Council's Draft Business Land Strategy[12] anticipated two additional motorway interchanges in the vicinity of Silverdale, to further support land use change and economic development in the area. The study found that the opening up of further land in Silverdale West for industrial activity would:

> *... require a new motorway interchange to service it (to the south of the Silverdale interchange). A new SH1 interchange is needed at Silverdale North to provide direct access into the Knowledge Economy zone. South-facing ramps are planned for Bankside Road. The staging of the Silverdale North is dependent on PENLINK being constructed as well as a new motorway interchange on SH1 at Bankside Road. Any development of the Silverdale West area for industrial land would be dependent on PENLINK being constructed.*

Therefore, we were in a position to use this assessment as a way of informing the discussion around these changes to the local transport network in the Silverdale area.

11.3 Approach to the analysis

The specific purpose of the analysis was to see if there were changes in the Silverdale community and its economy that could have been related to the increased accessibility consequent on the construction of the motorway interchange.

Through this, the case study aimed to explore whether data that was reasonably readily available was sufficiently detailed to allow an assessment as to whether or not there had been some elements of transformational change consequent upon the specific transport investment. Our eventual interest was in the economic changes that could be observed in the WTP for land or property in Silverdale as a consequence of the increased accessibility. However, with the approach we adopted, the data lent itself to following through a number of changes that took place in South and North Silverdale before, during and after the opening of the interchange, to provide both context and credibility to the changes in land value that we then observed, and to illustrate how a qualitative assessment tool could be deployed in practice.

We therefore presented empirical observational analysis on industrial and residential land use change, changes in residential population and employment, changes in accessibility, and then changes in land values.

Finally, we considered other changes in the urban nature of Silverdale through data and on-the-ground analysis as implied by the employment profile, and the range of uses of properties, which could indicate a change of urban function or a transformational step up the settlement hierarchy. We then presented some information on implied incomes generated in the Silverdale town as an indication of increase in total value of production (though not necessarily productivity) consequent on the changes.

Firstly, we set out the key data sources used and then from these we extracted the data for two relevant CAUs (Silverdale South and Silverdale North) to provide a baseline profile of the case study area in 1996.

12 RDC, 2010, Draft Industrial Land Strategy, p21.

11.4 Data sources

As noted, a key objective was to utilise easily accessed datasets where possible to develop a descriptive statistical picture. The following sources were relied upon:

- SNZ census data for 1996, 2001 and 2006 for demographic, employment and travel-to-work data – SNZ Business Demographic data was used to analyse employment and sectoral composition at the CAU level and could also be applied at the meshblock level
- BERL's database for demographics, employment, incomes and transport use in the travel to work in the CAUs in the three censuses of 1996, 2001 and 2006
- QVNZ Property Database's information on land values and property values, land uses, lot sizes and other relevant property characteristics – this dataset covered all CAUs in New Zealand for the years 1996–2009, by the 42 main land uses (BERL had selected the 1054 CAUs that could be characterised as urban and was using this database for a range of analyses, including those related to urban form, land value, industry profile and transport mode use)
- NZTA's State Highway Traffic Volumes 1999–2010 to provide traffic counts at locations within the case study area from 1999–2009.

Table 11.1 Data sources – descriptive statistics

Data source	Data type	Purpose in this study
SNZ census 2006, census 2001, census 1996	• Population • Employment status • Income	• Change in population and key socio-economic indicators
SNZ Business Demographics 2000–2010	*Employment size groups for geographic units* – provides geographic unit counts by ANZSIC group, employment size groups, by regional council/territorial authority/area unit	• Employment data to plot changes in economic structure (eg composition of employment by sector), levels of employment and how this compares with changes across wider region • Changes in numbers of firms within sectors
NZTA State Highway Traffic Volumes 1999–2010	Traffic counts	• Accessibility and transport trends locally in study area and in relation to regional trends • Effect on accessibility to labour supply
QVNZ Property Database	• Land and property values • Land use including changes • Site area, plus other characteristics of sites	• Land and property prices over time (ideally from pre-construction to 5 years of operation), at the local level and regionally • Commercial and industrial property rental levels and changes over time, at the local level and regionally
Others	Local retail turnover data	

It is worth noting for other applications of these datasets that while they have been scrutinised to ensure that each is consistent with the other (particularly at each census date), in detailed analysis of some specific CAUs we sometimes discovered some data disconnects. This was particularly where SNZ had changed the land area contained in a CAU, and QVNZ had not necessarily made that adjustment. For this particular application, our inspection of these two datasets for the two CAUs did not suggest any likely change of land area over the three censuses.

Expanding the qualitative assessment would be reliant on information sourced from councils, land agents and local observations, including those listed in the following table.

Table 11.2 Information sources – qualitative indicators

Data source	Purpose in this study
Council, real estate agents, local business associations	General commercial property market trends such as ownership patterns, movers in and out of business locations, including property agents' perspectives
QVNZ database, council information, real estate agents	Residential trends eg increase in housing stock Land availability and vacant land (and buildings), and consolidation of sites for development
Council report, local media	Proposals for changes of land use and development/redevelopment opportunities around assessment area
Council plans, Spatial Plan, District Plan, council reports	Zoning information
Ministry of Health	Social conditions, deprivation levels, etc around assessment area www.moh.govt.nz/moh.nsf/indexmh/dhb-maps-and-background-information-atlas-of-socioeconomic-deprivation-in-nz-nzdep2006
Council report, spatial analysis	Proximity to public facilities and/or open space (often seen as too complicated)

In this analysis we utilised planning and zoning information for the District and Regional council.

11.5 Step 2: Establish a baseline profile of the case study area prior to the project

Establishing a baseline prior to the project being constructed was important, in order to provide a comparator, post-project completion, and to identify any expectation effects that arose prior to or during construction.

Working from high-level data at the CAU level, at the 1996 census there were two CAUs covering Silverdale – Silverdale South and Silverdale North. In 1996 the usually resident population was 1347 in Silverdale South and 816 in Silverdale North, a total of 2163 people. There were limited urban characteristics of the Silverdale area in 1996. The maps following show the location and land area of the two area units.

Figure 11.2 Silverdale Area unit maps

Using QVNZ's property database, we examined observations on land use. In the QVNZ data there was no property listed as used for education in either CAU, so presumably there was no school. There was one property listed in Silverdale South as being used for health, presumably a health clinic/GP of some sort. There were 11 retail properties and 115 light industrial properties listed in Silverdale South, and none of either in Silverdale North. There were no properties used for religious purposes, and four were used for sporting purposes.

Thus, prior to the confirmation that access would be provided to the Orewa/Auckland motorway by the construction of an interchange at Silverdale, there was limited urban development in Silverdale. It was mainly a small location for light industry. The total employed in all workplaces in Silverdale (including rural properties) was recorded as 1527. Since the number available for employment from the 2163 total population would be of the order of 1100 to 1200, this implied that at least 300–400 people travelled into Silverdale to work in 1996.

Around Silverdale, much of the rural area was occupied by lifestyle blocks, with 439 in the two CAUs. In contrast, the data records only 77 straight residential properties, with an average size of a large 0.35 hectares. From 1998 the number increased rapidly to 350, which could well indicate subdivision of sections in anticipation of future demand.

11.6 Step 3: Establish the planning context applying to the case study area

The next step was to establish the planning context within the study area through an assessment of the relevant regional and local plans. This was important as it helped in understanding how a transport project could complement existing planning objectives for the area. It could also have revealed whether the outcomes arising from a project were unanticipated, and whether planning changes appeared to be more retrospective in nature, responding to pressure for land use change arising from a transport scheme – this could be to support the resultant land use changes, or to restrict them if they were deemed to be undesirable for that location.

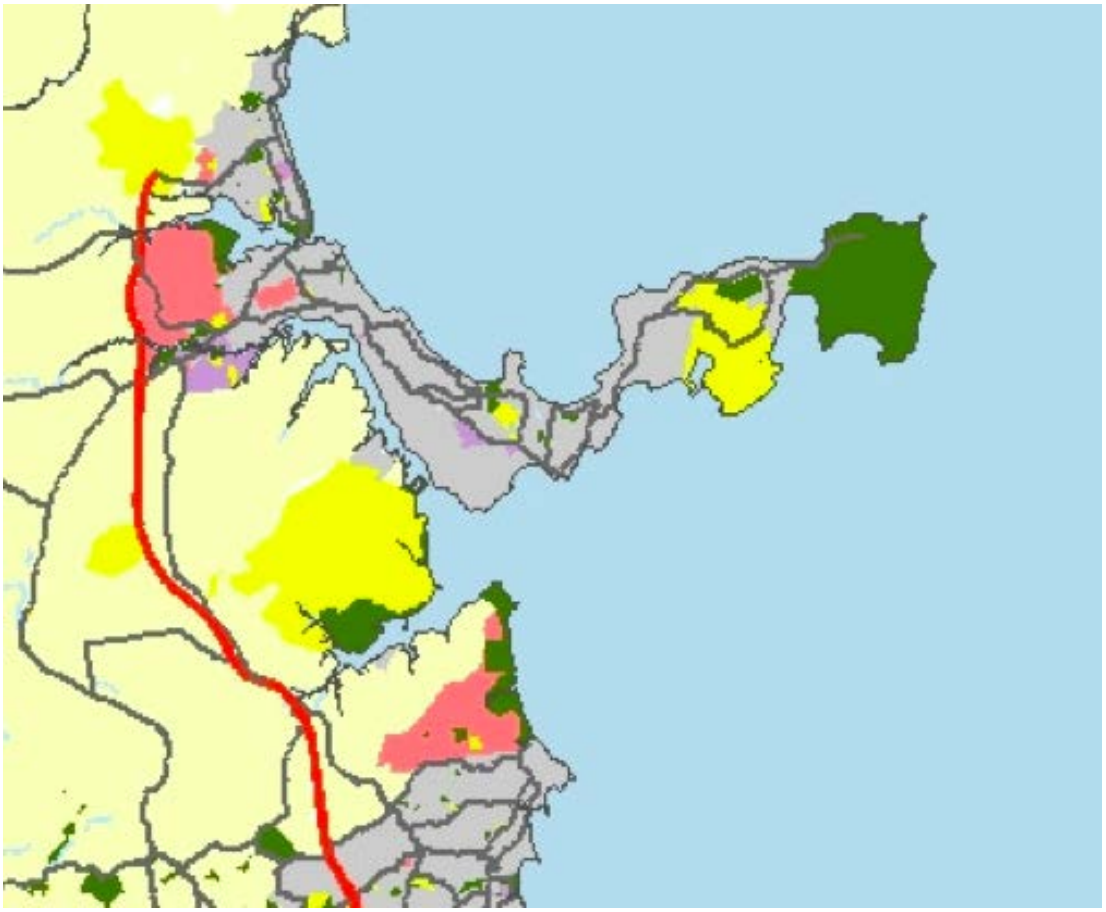
Although it was potentially challenging to get a fully accurate assessment of the motivations behind planning changes, there was real value in this step as it could assist in understanding how planning objectives and transport projects may or may not have been complementary in practice, and how better outcomes might have been achieved.

In this case the Auckland Regional Growth Strategy (ARGS) (or more precisely the 'Growth Concept' contained within the ARGS) and the Rodney District Plan were the most influential documents.

11.6.1 Regional planning framework

The case study area was identified in the 1999 ARGS 'Growth concept' map as being intended for future urban development. The attached schematic map identifies the two CAUs as being within the area identified for 'future urban' activity. Purple refers to existing industrial zoning, grey to existing residential zoning, and pink to future urban (with a large future growth area located in close proximity to the motorway interchange).

Figure 11.3 ARGS 'Growth concept' map – Silverdale wider area



The RMA requires any District Plan to give effect to the Regional Policy Statement, and the Regional Policy Statement for the Auckland region was required to give effect to the growth concept in the ARGS. Changes have been undertaken to the Rodney District Plan 2000 to align it with the ARGS.

The Northern and Western Sectors Agreement (which implement the ARGS) set out the form of future development in Rodney, including the location of large-scale residential development in the greenfield areas of Silverdale North and Orewa West.

The Sector Agreement also acknowledged the move of the Hibiscus Coast Metropolitan Urban Limit MUL westwards to the Northern Motorway in 1999 and noted the possible amendment of the MUL in the

Silverdale South area to accommodate an additional 84 hectares of land suitable for business or residential activity.

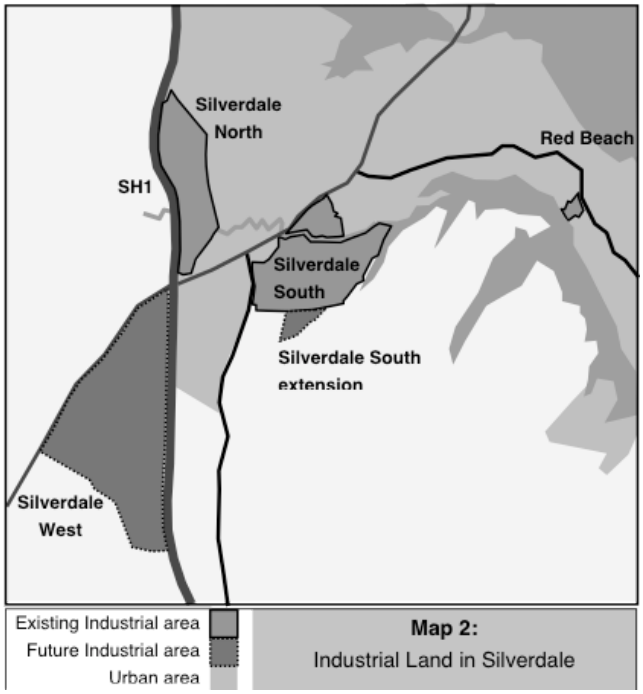
11.6.2 District planning framework[13]

The two CAUs within the study area had quite different planning characteristics. Silverdale South contained around 91ha of industrial-zoned land, as well as retail and some residential land. At the time of this research, Silverdale South's industrial land was almost at capacity, with few vacant sites. According to the previous Rodney District Council (RDC) (2010a), the focus of development in Silverdale South was to encourage intensification and better use of sites. A minor amount (8ha) of additional land was being provided in Silverdale South.

Silverdale North contained a large area of land zoned for intensive residential development and was also the location of a large parcel of land zoned for knowledge-intensive activities. Silverdale North (Knowledge Economy Zone) was a recently zoned and as-yet undeveloped area of business land. The zoning for this area provided for mixed use, including residential and commercial development (although with limited retailing). While Silverdale North was intended as a specialised campus-like setting for knowledge-intensive business, it was also expected to accommodate industrial activities, with the possibility that these could account for perhaps one-third of the zone. RDC envisaged that it was likely to begin to develop when the Silverdale North residential area was occupied. However, RDC noted that the release of land would be contingent on arrangements for local traffic movement (Wainui motorway access) and the development of Penlink to reduce pressure on the Silverdale intersection of the SH1 motorway.

The industrial areas in Silverdale are shown on the map below.

Figure 11.4 Silverdale industrial land (RDC 2010a)



13 See appendix C for the RDC District Planning zoning maps.

A summary of the amount of existing and future industrial land (as in 2010) in the Silverdale area is shown in the table below.

Table 11.3 Industrial land in Silverdale (2010) (RDC 2010a)

Silverdale industrial areas	Existing zoned land (ha)	Vacant land left (ha)	Greenfields planned (ha)
Silverdale South	92	8 (9%)	8
Silverdale North	20	20 (100%)	0
Silverdale West	0	0 (0%)	226
Red Beach	4	0 (0%)	0
TOTAL	**116**	**28 (24%)**	**234**

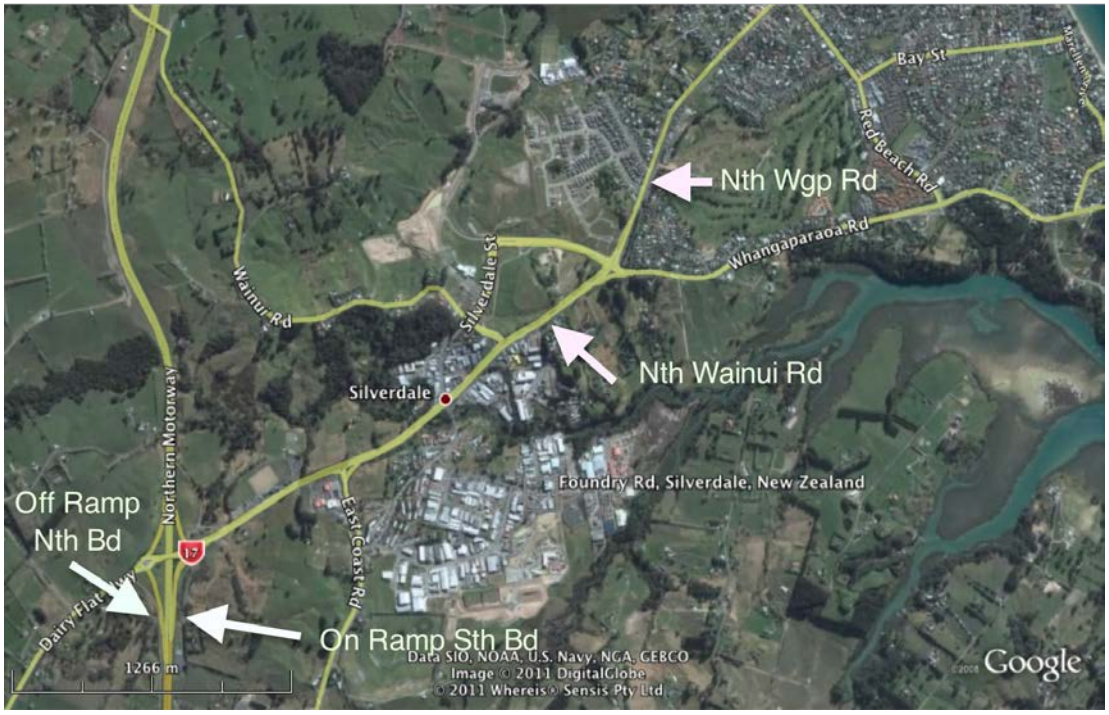
At the local level, the study area was subject to a number of planning initiatives to allow for increased residential development.

In the early 2000s the RDC proposed variation 52 to the proposed 2000 district plan. This zoned the Totara Views area of Silverdale South for medium-intensity residential development and provided for the rezoning of a further 400ha, mostly in the Silverdale North structure plan area, for residential dwelling. This applied to an area bounded by State Highway 1A to the west, the Orewa Estuary to the north, Jelas Rd to the east, and the Hibiscus Coast Highway (SH1) to the south. In the Totara Views area of Silverdale South, permission was granted by RDC for subdivision by Universal Homes Ltd into about 300 lots.

11.7 Step 4: Travel patterns and accessibility

To gain a feel for the changes in travel patterns and accessibility and travel patterns within the study area following the completion of the project, we examined selected data on local traffic flows extracted from NZTA's (2009c) State Highway Traffic Volumes records. We isolated traffic counts at a number of sites to the north of the motorway interchange on the Hibiscus Coast Highway, which runs from the motorway via Silverdale to connect with Whangaparaoa Rd north of Wainui Rd and then carries onto Orewa. We also examined traffic counts on the motorway north and south of the interchange and flows on the southbound (city-bound) on-ramp and northbound off-ramp).

Figure 11.5 Traffic count locations



Examining the data, we saw that traffic volumes on the motorway south of the interchange had climbed steadily over the period 2001–2009 (Silverdale on-ramp to Otheha Valley Rd Southbound). From 2001 to 2008, the average vehicles per day on the northern motorway increased from 15,750 to 20,844 (32.3%). Between 2001 and 2009, the majority of this traffic accessed the motorway at the Silverdale interchange, and between 2001 and 2008, this traffic accounted for the majority of the growth in traffic volumes on the motorway south of Silverdale.

However, in 2009 a noticeable change occurred with traffic entering the motorway at Silverdale, declining (from 13,754/vehicles day to 13,056/vehicles day), whilst traffic passing south through the interchange on the motorway increased significantly, from 7080 vehicles per day to 8802 vehicles per day. One consideration could be that increasing congestion in the Silverdale area was encouraging more traffic to use the motorway as a bypass for the area.

This pattern was also evident in more localised traffic on the Hibiscus Coast Highway (shown as Nth Wainui Rd), which rose steadily until 2007 but then began declining, as did traffic north of Whangaparaoa Rd. Again, this is consistent with through traffic seeking to avoid the area and suggests that capacity was being reached at peak times, or at least that alternative routes were becoming more attractive for some drivers. However, another factor could be the opening of ALPURT B2, leading to traffic remaining on the motorway rather than travelling via Silverdale and Orewa.

Figure 11.6 Traffic volumes Silverdale area (AADT[14])

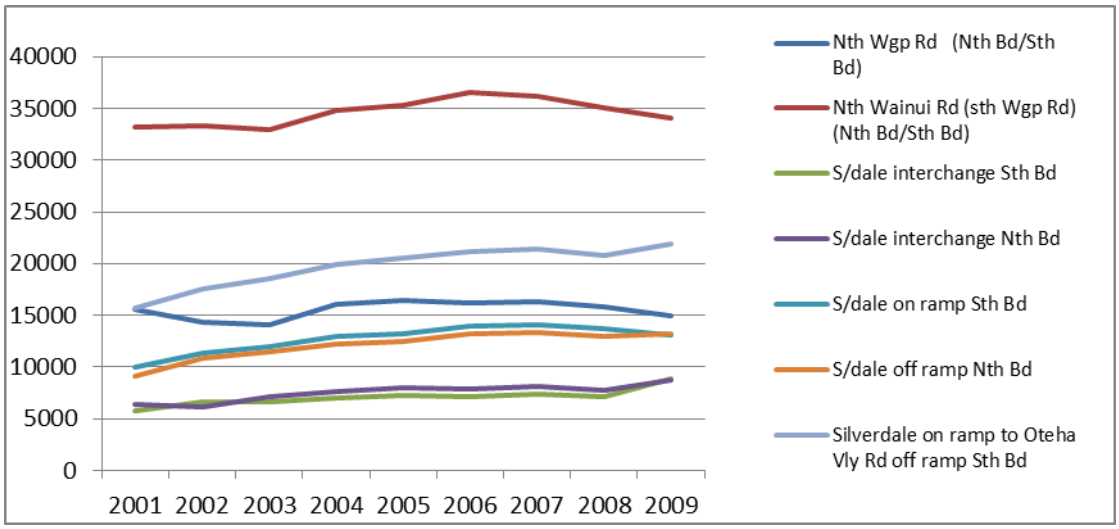


Table 11.4 Traffic volumes Silverdale area (AADT) (NZTA 2011)

	2001	2002	2003	2004	2005	2006	2007	2008	2009
Nth Wgp Rd (sth-bd/sth-bd)	15,610	14,380	14,140	16,050	16,421	16,148	16,356	15,802	14,947
Nth Wainui Rd (sth Wgp Rd) (nth-bd/sth-bd)	33,250	33,300	33,000	34,860	35,272	36,614	36,237	35,023	34,114
S/dale interchange sth-bd	5780	6660	6630	6960	7252	7176	7351	7080	8802
S/dale interchange nth-bd	6330	6170	7160	7650	7963	7824	8084	7702	8799
S/dale on ramp sth-bd	9980	11,330	11,960	12,910	13,241	13,948	14,067	13,764	13,056
S/dale off ramp nth-bd	9140	10,880	11,420	12,210	12,440	13,167	13,322	12,995	13,214
Silverdale on ramp - Oteha Vly Rd off-ramp sth-bd[a]	15,750	17,500	18,600	19,880	20,493	21,124	21,418	20,844	21,858

a) Traffic counts for northbound are identical.

11.8 Step 5: Results of changes in residential land use, dwellings and population

Next we looked at applying the QVNZ datasets to assess observed changes in residential land use in the case study area. Around Silverdale, much of the rural area was occupied by lifestyle blocks, with 439 in the two CAUs. In contrast, the data recorded only 77 straight residential properties, with an average size of 0.35 hectares. From 1998 the number increased rapidly to 350, which could well indicate subdivision of sections in anticipation of future demand. Unfortunately the QVNZ database that BERL had access to did not separate the occupied residential properties from those that were vacant. Therefore, we could not obtain a chart of the anticipatory subdivisions and then the occupation of these residential properties in the same way as we could for industrial land.

14 AADT – annual average daily traffic

What we can show, however, is that from 1999 there was a steady increase in the total number of residential and lifestyle properties in Silverdale.

Figure 11.7 Residential property numbers in Silverdale 1995–2009

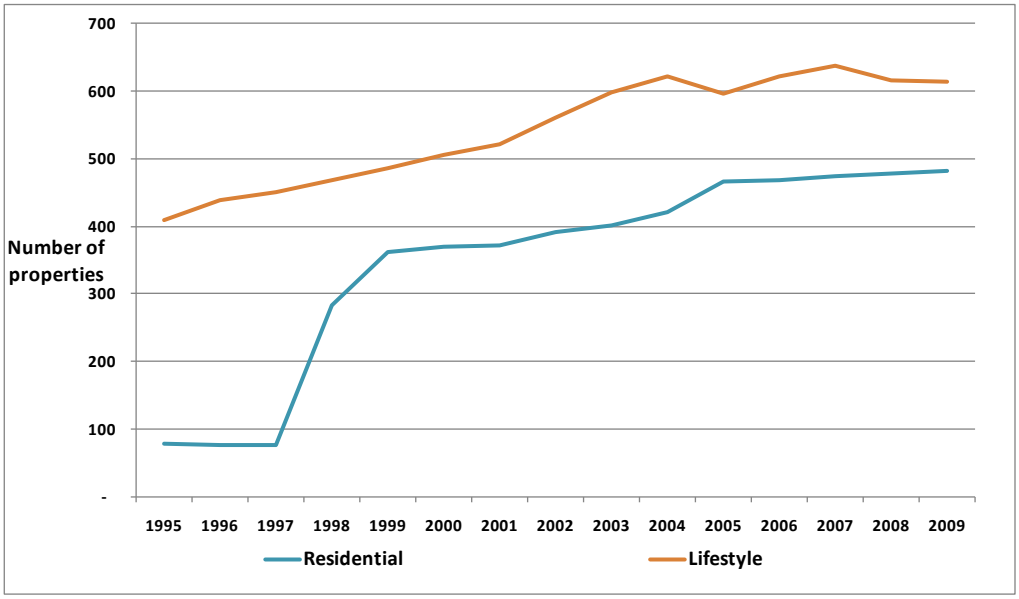


Table 11.5 Residential property numbers in Silverdale 1995–2009 (BERL 2011)

Property land use		1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Residential	*Hectares*	27.8	27.0	26.6	48.1	54.5	59.5	60.9	61.3	61.4	76.8	236.2	235.2	236.9	284.0	283.2
	Count	78	77	76	284	361	369	372	391	401	422	466	469	474	478	482
Lifestyle	*Hectares*	2,325.5	2,486.5	2,498.5	2,583.8	2,609.1	2,629.3	2,609.4	2,636.6	2,926.2	3,027.9	3,018.1	3,043.7	3,061.6	2,870.1	2,685.9
	Count	409	439	451	469	486	506	522	561	599	622	597	621	637	615	614
Rural	*Hectares*	1,742.3	1,713.4	1,708.3	1,635.1	1,655.9	1,290.0	1,274.3	1,218.5	1,176.4	1,070.9	999.1	995.9	999.3	998.2	998.2
	Count	15	14	14	13	12	11	11	9	10	11	8	7	7	6	6
Total with Residents	*Count*	502	530	541	766	859	886	905	961	1,010	1,055	1,071	1,097	1,118	1,099	1,102

The major increase in number of residential properties between 1997 and 1999 should be explored further by either obtaining more information from QVNZ if that is available, and/or from the local authority, in order to verify this step-increase, and/or find the number of vacant properties. We could also compare with recoded changes in population data available from SNZ.

11.8.1 Changes in occupied dwellings

It is relatively easy to supplement this analysis using SNZ census data. Using the dataset 'Occupied dwelling count for area units in the Auckland Region and Rodney District, 1996, 2001 and 2006', we examined changes in dwelling numbers for the two Silverdale CAUs compared with changes at the district and regional level.

Table 11.6 Occupied dwellings Silverdale, District and Region 1996–2006

	1996	2001	2006
Silverdale South	486	576	729
Silverdale North	252	297	345
Silverdale CAUs total	738	873	1074
Silverdale CAUs % change		18.3%	23.0%
District total	24,450	28,668	33,444
District % change		17.3%	16.7%
Region	355,359	393,264	437,988
Region % change		10.7%	11.4%

The general pattern observed was one of strong growth in occupied dwellings, relative to the observed patterns at the district and regional level. In particular, Silverdale south experienced a significant increase in occupied dwelling numbers, accounting for 243 of the additional 336 occupied dwellings in the two CAUs.

11.8.2 Population changes

Using census data on usually resident population, we examined trends in the study area and comparator locations. The usually resident population of 2163 in 1996 had increased to 2526 by 2001, an increase of about 360 people. There was a stronger increase, of about 560 people, to a total of 3081 by 2006. In the 10-year period, the population increased by 42%.

However, we did not find a change in population that matched the sudden increase in residential properties between 1997 and 1999 that was indicated in the QVNZ data. A possible explanation is that the QVNZ data was reflecting residential sections, with a significant level of subdivision taking place between 1997 and 1999 and then developed over time. Further analysis is needed to address this point.

Table 11.7 Usually resident population – Silverdale

	1996	2001	2006
Silverdale CAUs	2163	2526	3081
% Δ between censuses		16.8%	22.0%
% Δ 1996–2006			42.4%

The census data again allowed for disaggregation in the case study area by CAU, and also comparison with district and regional trends. The results again confirmed the strong population growth experienced in the case study area over the 10 years, relative to district and regional patterns. The results also emphasised the strong concentration of population growth in the Silverdale South CAU, with population in the CAU growing by over 50% in the 10 years. Silverdale North, on the other hand, actually grew at a slower rate than the district average.

Table 11.8 Usually resident population – Silverdale CAUs compared with district and regional trends

	1996	2001	2006
Silverdale South	1347	1611	2070
% Δ between censuses		19.6%	28.5%
% Δ 1996–2006			53.7%
Silverdale North	816	915	1011
% Δ between censuses		12.1%	10.5%
% Δ 1996–2006			23.9%
Rodney District	66,483	76,185	89,559
% Δ between censuses		14.6%	17.6%
% Δ 1996–2006			34.7%
Auckland Region	1,068,645	1,158,891	1,303,068
% Δ between censuses		8.4%	12.4%
% Δ 1996–2006			21.9%
% Δ 1996–2006			

To gain more insights about recent changes, it was useful to interrogate the annual time series data available from SNZ. Using the dataset 'Estimated sub-national population (TA,AU) by age and sex at 30 June 2006–10' we looked at the annual changes in population at the CAU level and compared them with district and regional trends.

The data confirmed that within the study area, Silverdale South had continued to accommodate most of the local population growth and this had continued at a faster rate than at the district and regional level. Silverdale North, however, had shown very little growth and lagged both regional and district averages by a notable margin. Given the planning context, this might be expected to change as Silverdale South reaches capacity.

Table 11.9 Population growth 2006–2010

	2006	2007	2008	2009	2010
Silverdale South	2140	2230	2300	2370	2420
Silverdale South % Δ		4.2%	3.1%	3.0%	2.1%
Silverdale North	1040	1060	1060	1070	1080
Silverdale North % Δ		1.9%	0.0%	0.9%	0.9%
Total RDC	91,540	93,790	95,570	97,250	99,130
RDC % Δ		2.5%	1.9%	1.8%	1.9%
Region TOTAL	1,372,930	1,396,210	1,416,860	1,438,630	1,462,010
Region % Δ		1.7%	1.5%	1.5%	1.6%

11.9 Step 6: Results of changes in land use

11.9.1 Industrial land use

There is evidence that there was a change in industrial land use stimulated by the confirmation that the interchange was to be constructed. The QVNZ property data shows the industrial land that was occupied and that which was vacant. Through to 1997 there were 33 hectares of industrial land occupied and 25 hectares vacant. By 1999 there was a small increase, to 40 hectares, occupied and a substantial increase, to 50 hectares, of vacant land available for industrial use.

This indicates that developers were stimulated to subdivide property anticipating an increase in demand for land for industrial use. Once the interchange was operational, the demand did increase so that the vacant industrial land was taken up through to 2008. By then, industrial land occupied was 55 hectares. Looking at the change in area of vacant industrial land, the increase from 25 hectares in 1997 to 50 hectares in 1999, then reduction to 38 hectares in 2000, may indicate that the industrial designation was obtained for a larger area, and then some of that land was found to be unsuitable for industrial development and was allowed to revert to other uses. This process may have reoccurred between 2007 and 2009. In 2007 it appears that the property developers anticipated a continuing expansion of demand and a further 15 hectares was developed. The global financial crisis and/or exclusion of some unsuitable land may well have caused some reversal of this move in 2009. The changes are shown in the following graph and table.

Figure 11.8 Industrial land use changes in Silverdale South 1995–2009

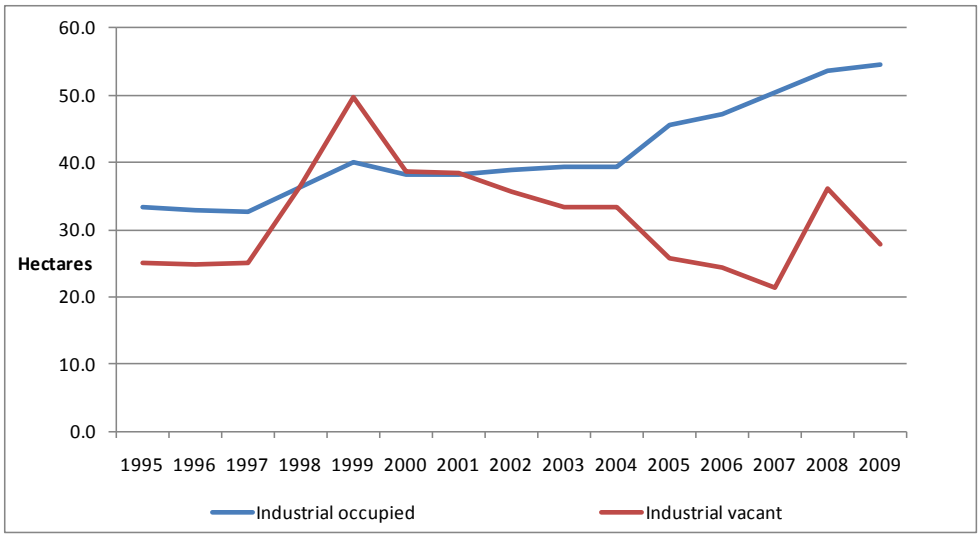


Table 11.10 Industrial and commercial land use and property counts Silverdale South 1995–2009 (BERL 2011)

Property land use		1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Industrial occupied	*Hectares*	33.3	32.8	32.7	36.5	40.0	38.3	38.3	38.8	39.3	39.3	45.6	47.3	50.3	53.6	54.6
	Count	116	118	123	130	153	154	166	164	167	171	182	189	200	221	244
Industrial vacant	*Hectares*	25.0	24.8	25.1	36.6	49.6	38.7	38.4	35.6	33.5	33.5	25.7	24.5	21.4	36.1	27.8
	Count	47	53	55	53	51	54	51	46	62	62	57	57	46	46	36
Commercial occupied	*Hectares*	2.3	2.3	2.3	4.0	4.9	5.0	5.0	4.9	4.9	4.9	4.9	4.9	4.9	5.0	7.0
	Count	14	14	14	16	25	29	29	29	29	29	29	29	29	30	31

The phenomenon of industrial development in anticipation of increased access through motorway interchanges was analysed by Pugh (2005) in the UK, using survey and empirical data of the impact of the M6 Toll on southern Staffordshire. Pugh also measured the impact on industrial development within specific drive-time distances. He found for 5 minutes' drive time, the impact was high; for 10 minutes the impact was moderate; and for 15 minutes the impact was minimal.

He measured a number of other quantitative and qualitative impacts, including positive effects on existing firms, which were not just travel time benefits. These were 'additional' rather than 'displacement' effects.

It would be instructive to investigate all the elements of this process in Silverdale in more detail. This should include some on-the-ground surveying of the original and the new businesses to see whether the same types of effects can be measured *ex post* in Silverdale, and thus verify that Pugh's findings apply in the New Zealand context.

11.9.2 Commercial land use

The pattern of commercial land use in the Silverdale South CAU was consistent over the period. In 2004 there were some developments in the Silverdale North CAU for retail and in commercial mixed use. There were also significant areas of property designated as commercial vacant recorded from 2005 to 2008. The reality of the changes in the actual areas of land and numbers, and the nature of properties developed and/or occupied, cannot be recognised without ground-referencing inspection of the actual properties.

Suffice it to say that the period 2005 to 2008 saw significant development of retail and commercial mixed-use properties in Silverdale, following on from the industrial land development that began in 1997.

One effect of interest that is revealed in the following section is that observed employment changes were lagging land use changes. This is to be expected, with development leading economic activity. It suggests that QVNZ data may provide the better 'early indicator' of economic transformation.

11.10 Step 7: Results of changes in Silverdale's economic structure and composition

To examine the economic structure of the Silverdale area, and changes in its composition over time in more detail, we investigated using SNZ's business demographic datasets such as 'Detailed industry by region for geographic units'. These provide a high level of detail by sector at the area unit level.

11.10.1 General growth in employment

Firstly, we examined changes in the level of employment in the Silverdale area between 2000 and 2010 and compared them with the averages for the Rodney District and Auckland Region. This revealed a strong and continued trend of employment growth well above the average, as the following table illustrates.

Table 11.11 Employment growth – comparison of the Silverdale area with Auckland Region and Rodney District 2000–2009 (SNZ 2011)

	Auckland Region	% Δ from 2000	Rodney District	% Δ from 2000	Silverdale area	% Δ from 2000
2000	519,240		17,520		1974	
2001	521,340		17,700		2012	
2002	533,350		18,290		1991	
2003	555,990		19,660		2327	
2004	580,490		20,970		2479	
2005	601,520	15.8%	21,980	25.5%	2997	51.8%
2006	616,240		22,800		3066	
2007	629,460		23,330		3129	
2008	645,780		24,590		3441	
2009	624,590		23,050		3254	
2010	611,950	17.9%	22,480	28.3%	3212	62.7%

We then disaggregated the data to examine employment changes within the two CAUs covering the study area. The table below notes the absolute and percentage changes in population for 2005 and 2009 for both CAUs.

Table 11.12 Employment changes – area, district and region 2000–2009 (SNZ Table Builder 2011)

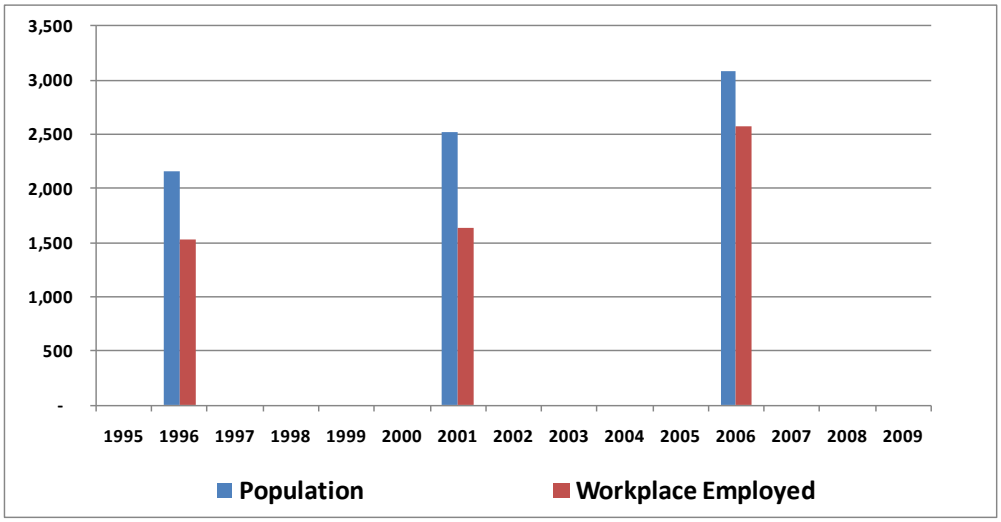
	Silverdale South	Silverdale North	Rodney District	Auckland Region
Change 2000-05	925	137	3781	82,390
% Δ 2000-05	50%	101%	24%	16%
Change 2000-09	1168	319	4699	105,140
% Δ 2000-09	63%	235%	30%	20%

On the basis of this data, it appears that although the rate of employment growth within Silverdale North was significantly higher than that in Silverdale South, the majority of employment in the area was still strongly concentrated in Silverdale South. This is to be expected, as this CAU covered the industrial area to the east of the Hibiscus Coast Highway. Employment within this CAU had also been growing significantly faster than the district or regional average, and in absolute terms, the vast majority of new jobs in the study area were created in Silverdale South (1168) compared with Silverdale North (319).

11.10.2 Comparing changes in workplace employed and resident population

Using census data, we then examined workplace employed estimates. We observed that the total number of people employed in Silverdale increased by only 100 between 1996 and 2001, from 1527 to 1635; however, there was then a step-increase to 2568 by 2006. This was a 10-year increase of 1040, or 68%. These changes could imply that the increased accessibility of Silverdale was more attractive to businesses than it was to residents, even with the zoning changes adopted by the council. The graph below illustrates comparatively the changes in working population employed against changes in usually resident population for Silverdale between 1996 and 2006.

Figure 11.9 Census changes in residents and working population employed 1996–2006



11.10.3 Comparisons with other employment centres

For this study it was felt that a comparison with similar centres or areas might help to identify any unique trends and patterns in the case study area. We chose four comparative centres in close proximity to Silverdale, with two centres located on the SH1 corridor (Orewa and Warkworth) and two centres located on SH17, which received little investment over this period (Kumeu and Helensville). The results are shown in the following table and graphs.

Table 11.13 Employment changes in other centres – SH1 and SH17 corridors (SNZ 2011)

		SH1 corridor		SH17 corridor	
Year	**Silverdale**	**Orewa**	**Warkworth**	**Kumeu**	**Helensville**
2000	1974	1970	2200	2430	560
2001	2012	1920	2220	2310	560
2002	1991	2080	2220	2370	580
2003	2327	2130	2410	2600	710
2004	2479	2240	2550	2880	600
2005	2997	2390	2590	2650	620
2006	3066	2550	2800	2760	730
2007	3129	2610	2930	2750	750
2008	3441	2740	2970	2980	780
2009	3254	2530	2920	2760	720
2010	3212	2550	2850	2610	710

Figure 11.10 Employment changes – SH1 corridor centres

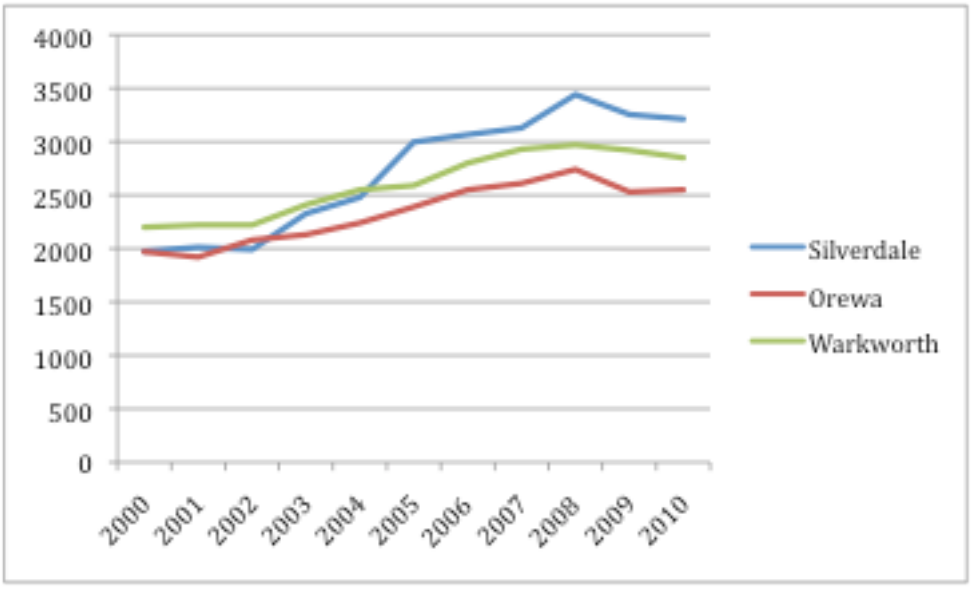
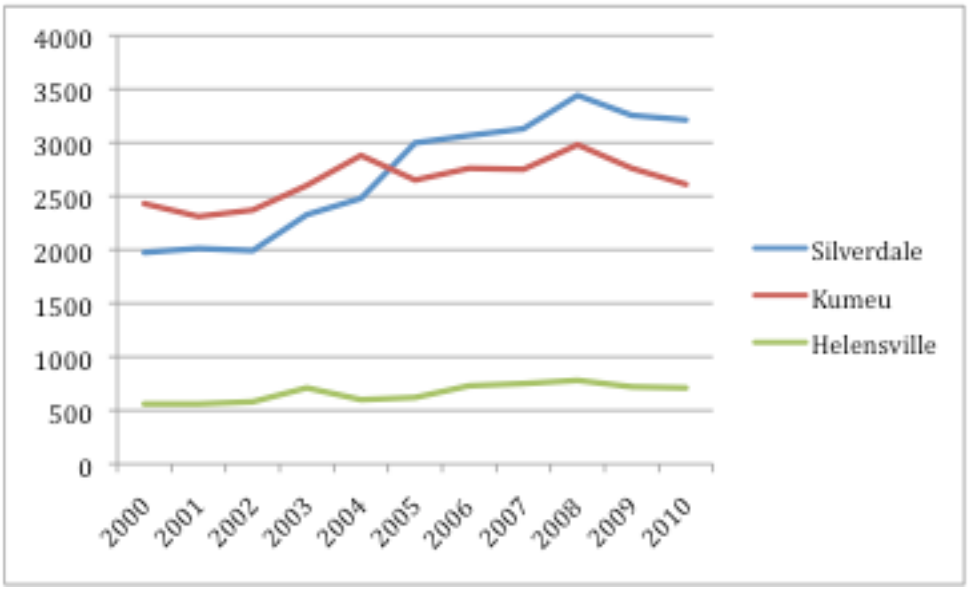


Figure 11.11 Employment changes – SH17 centres

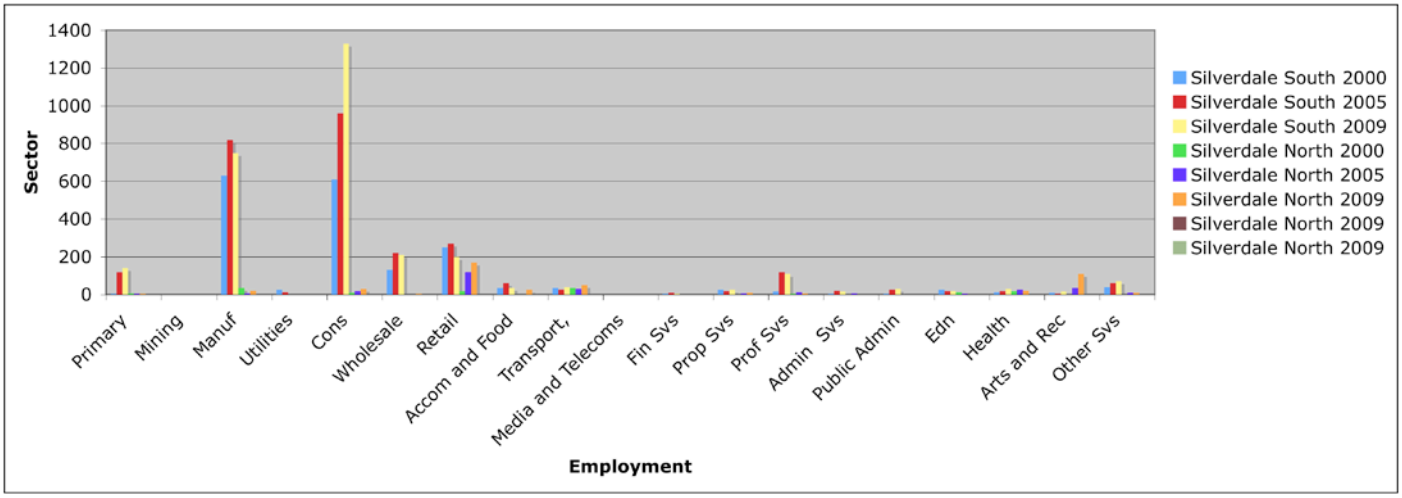


In both comparisons it is clear that Silverdale was performing well and had become the largest employment centre of the five. For the centres located on SH1, all three had grown strongly, but employment in Silverdale had increased at the greatest rate and it was clearly the largest employment centre of the three. The centres located on SH17 showed little growth in employment and Silverdale had easily eclipsed Kumeu in terms of employment numbers. The patterns suggest that locations on the SH1 corridor had been more successful in attracting employment growth over the 10-year period, and of these, Silverdale had seen the most noticeable increase. However, we do not know the nature of these changes in terms of the types of jobs created and their likely reliance on the transport investments.

11.10.4 Employment by sector

Data relating to employment structure provided a useful way of identifying business land use patterns within a particular area. By examining data contained within SNZ's Business demographics 2000–2010 datasets, we could see that employment in the study area was strongly concentrated in just a small number of sectors. The major source of employment was the construction sector and this activity was strongly concentrated in Silverdale South. In 2000, construction activity accounted for 32% of employment in Silverdale South (610 jobs) and by 2009 this had risen to 44% (1330 jobs).

Figure 11.12 Employment by sector for Silverdale CAUs 2000, 2005, 2009

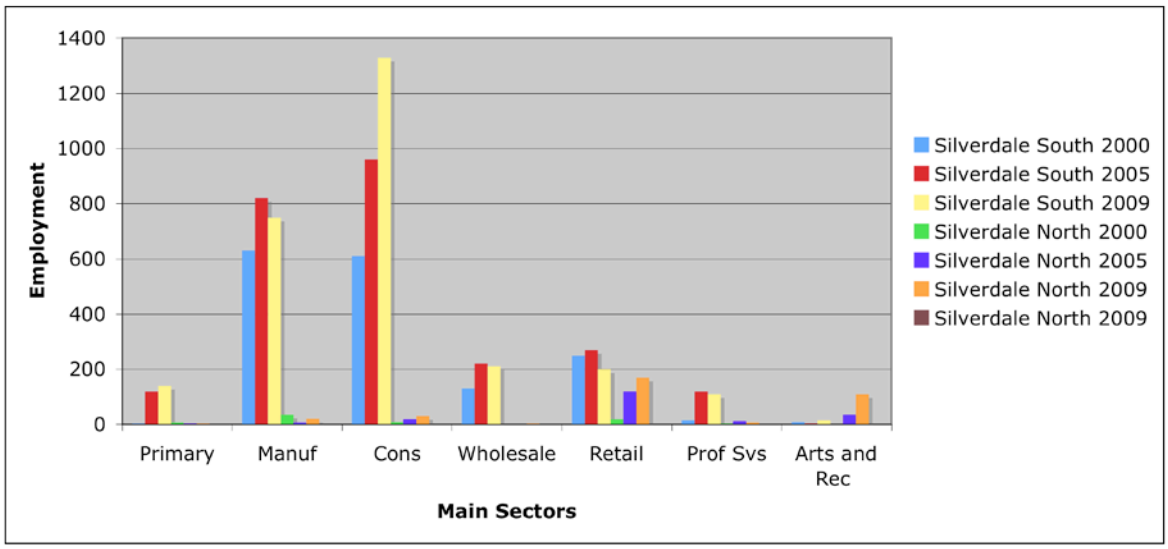


Other important sectors were manufacturing, wholesale and retail. Manufacturing was the second largest employer in Silverdale South after construction, accounting for 34% of jobs in 2000, and although the proportion of employment had fallen to 25% of jobs in 2009, the total number of jobs in this sector had increased slightly.

For Silverdale North, employment was very low in 2001, with transport (35 jobs) and manufacturing (35 jobs) the largest sectors from a total of 136 jobs. In 2009 total employment was 456 jobs, with retail (170 jobs) the largest employer, followed by arts and recreation services (110 jobs).

The following graph highlights the sectors containing most employment for the two CAUs.

Figure 11.13 Employment by main sectors for Silverdale CAUs 2000, 2005, 2009



This clearly shows the strong concentration of employment in the construction and manufacturing sectors in the Silverdale South CAU. It also emphasises the strong growth in construction employment in Silverdale South, which is explored further in the next section.

11.10.5 Employment changes over time

To examine the structural changes within the area of interest in more detail, compare these changes with broader trends, and hopefully shed some light on the land use changes happening in the study area, we drilled down into the employment data and examined trends at the activity and subactivity levels for the area, district and region.

To do this we firstly examined the data at the 1-digit or 19-sector level, and then at the 2- and 3-digit levels, using data extracted from SNZ's 'Employment size groups for geographic units' datasets (2011), which provide geographic unit counts and employment-size groups, by ANZSIC group, for regional councils, territorial authorities and area units.

In the following table we summarise the data at the 1-digit level, focusing on the sectors in which the main changes in employment levels in the two CAUs had occurred (appendix tables A.1 and A.2 provide the detailed data for all 1-digit sectors).

Table 11.14 Employment changes by selected sectors: area, district and region 2000–2009 (1-digit level)

	Ag, forestry & fishing	Manufacturing	Construction	Prof, scientific & tech svs	Arts & rec svs	Total
Silverdale South						
% Δ 2000–05	3900%	30%	57%	700%	-67%	50%
% Δ 2000–09	4567%	19%	118%	633%	67%	63%
Change 2000–05	117.0	190.0	350.0	105.0	-6.0	925
Change 2000–09	137.0	120.0	720.0	95.0	6.0	1168

	Ag, forestry & fishing	Manufacturing	Construction	Prof, scientific & tech svs	Arts & rec svs	Total
Silverdale North						
% Δ 2000–05	-50%	-83%	100%	300%	0%	101%
% Δ 2000–09	-50%	-43%	233%	100%	0%	235%
Change 2000–05	-3.0	-29.0	9.0	9.0	35.0	137
Change 2000–09	-3.0	-15.0	21.0	3.0	110.0	319
Rodney District						
% Δ 2000–05	-50%	16%	19%	74%	20%	24%
% Δ 2000–09	-50%	8%	29%	94%	38%	30%
Change 2000–05	-3.0	390.0	359.0	400.0	80.0	3781
Change 2000–09	-3.0	180.0	537.0	510.0	150.0	4699
Auckland Region						
% Δ 2000–05	4%	4%	36%	38%	26%	16%
% Δ 2000–09	-9%	-8%	41%	64%	45%	20%
Change 2000–05	230.0	3530.0	8720.0	14,580.0	1980.0	82,390
Change 2000–09	-570.0	-6510.0	10030.0	24,210.0	3460.0	105,140

For Silverdale South, the sectors providing the most additional jobs were primary (agriculture, forestry and fishing), manufacturing, construction and professional, and scientific and technical services. In Silverdale North, the arts and recreation services sector had seen the largest increase in employment.

An immediate observation is that of the 1168 additional jobs created in Silverdale South, 720 (62%) of these had been created in the construction sector. An obvious question is whether this might have been related to local employment associated with the residential intensification of the area. It is also apparent that the increase in construction employment for the district, at 537 new employees, was less than the increase in Silverdale South (720 employees), so employment in construction activity in Rodney, excluding Silverdale South, fell by 183 jobs over this period.

Interestingly, 137 jobs were created in primary activities, which might have been partly related to a large area of pine forest located at the edge of the CAU. The addition of 120 manufacturing jobs was also interesting, as employment in this sector was declining at the regional level, and so this was a noticeable point of difference.

To explore the changes in construction activity in more detail, we then drilled down to the 2-digit ANZSIC code level. The table below shows that construction employment in Silverdale South was actually concentrated in heavy and civil engineering construction and construction services, with building construction only accounting for 75 out of 1405 jobs in 2010.

Table 11.15 Employment changes, construction activity – Silverdale CAUs by 2-digit ANZSIC classification 2000–2010

	E30 building construction		E31 heavy and civil engineering construction		E32 construction services	
	Silverdale South	Silverdale North	Silverdale South	Silverdale North	Silverdale South	Silverdale North
Year	Employee count	Employee count	Employee count	Employee count	Employee count	Employee count
2000	18	0	470	0	120	6
2001	20	3	460	3	95	9
2002	9	0	410	0	130	9
2003	30	0	540	0	150	6
2004	30	6	560	0	150	6
2005	40	9	630	0	300	9
2006	30	0	670	0	330	15
2007	40	18	750	0	380	18
2008	85	3	800	0	510	25
2009	80	3	810	3	440	25
2010	75	3	780	0	450	25

The example of the construction sector illustrates the need to look into the disaggregated data to really understand the drivers of change in local employment. For Silverdale South, the vast majority of additional jobs were created in heavy and civil engineering construction (310 additional jobs) and construction services (330 additional jobs). Therefore the data suggests that this growth was not likely to be directly related to residential construction activity in the local area. On the other hand, the 57 additional jobs in building construction could well be a product of the residential intensification in the area.

Drilling down to the 3-digit level added further depth and detail to the patterns of employment. This revealed that the single largest concentration of employment in the study area was in the land development and site preparation services.

Table 11.16 Employment changes construction activity – Silverdale CAUs by 3-digit ANZSIC classification 2000–2010 (ANZSIC 2006 – Employment size groups for geographic units)

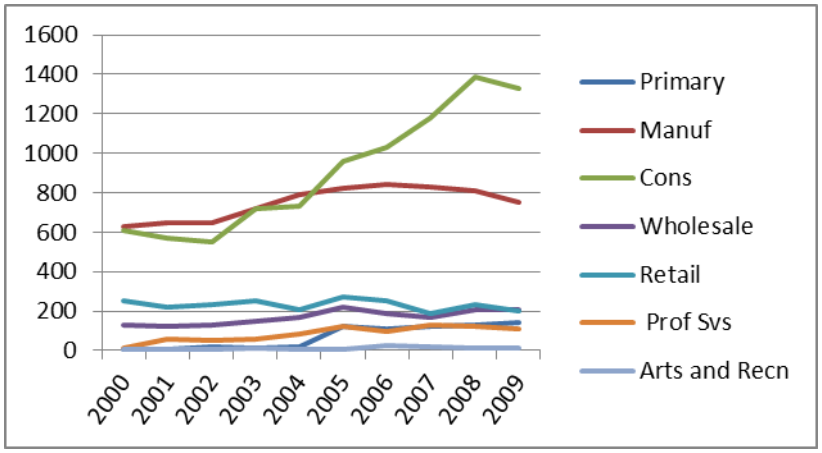
	E301 residential building construction	E321 land development & site preparation svs	E322 building structure svs	E324 building completion svs	E329 other construction svs
2000	3	70	0	6	25
2001	9	55	0	15	3
2002	3	95	0	15	3
2003	9	100	3	25	9
2004	12	75	6	25	18
2005	18	140	40	50	50
2006	9	190	40	40	30
2007	18	230	20	35	55

	E301 residential building construction	E321 land development & site preparation svs	E322 building structure svs	E324 building completion svs	E329 other construction svs
2008	60	280	50	60	60
2009	55	230	50	55	55
2010	55	230	50	50	40

An important purpose of this analysis was to demonstrate the level of detail available from open access data provided on SNZ's website. This was relatively easy analysis and provided very useful insights into the nature of employment and the economic structure of CAUs over a 10-year period. It provided a good insight into the types of activities being undertaken in the study area and the land use changes that had been taking place. Overall, from the employment data we could confirm a picture that was consistent with the planning framework, with a growing concentration of industrial activity within the south.

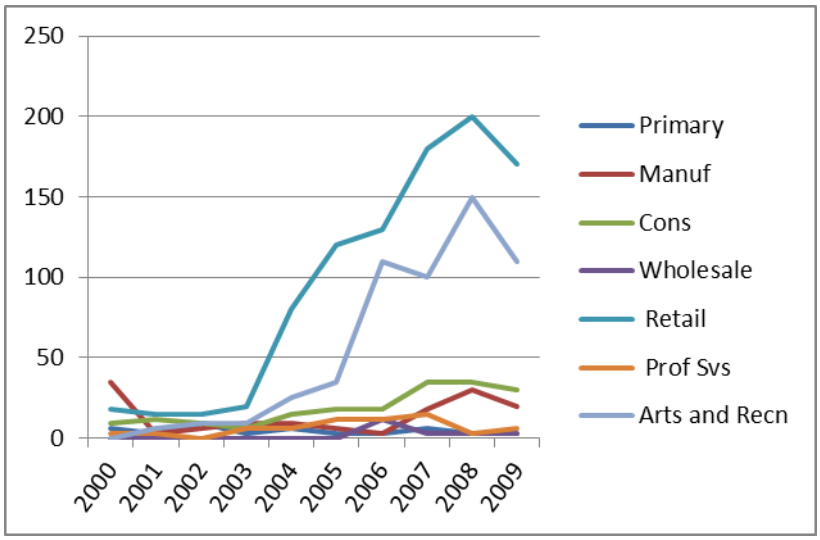
Building on the structural employment analysis, we were able to provide a picture of the changing patterns of land use over time for the study area. One way of doing this was to graph key variables, as this provided an easy way of visually inspecting the data. The indicators we looked at were employment in key sectors for both CAUs. One important purpose of this part of the analysis was to help unpick the timing and pace of changes in land use.

Figure 11.14 Employment changes, key sectors Silverdale South



The graph illustrates the notable increase in construction and manufacturing employment that took place in Silverdale South from around 2002 onwards, or within two years of the completion of the interchange. Interestingly, this trend in the construction sector then continued strongly until the economic downturn in 2008. Manufacturing employment tailed off around 2005 and slowly declined from 2006 onwards.

Figure 11.15 Employment changes, key sectors Silverdale North



In Silverdale North, although the absolute numbers of new jobs were significantly less than in Silverdale South, and the area was starting from an extremely low employment base, the changes in employment in two sectors were quite noticeable. Employment in retail activity responded strongly from 2002, and arts and recreation activity from 2004, although both were hit by the economic downturn in 2008.

In both CAUs, the rate of change in sectors in which a strong employment response could be observed appeared to be lagging behind the completion of the interchange by two to three years.

11.11 Step 8: Results for changes in land values and productivity

11.11.1 Changes in land values

The land values for commercial, industrial and residential land have increased considerably since 1996. There has been an increase in the value of all urban land, but further analysis shows that the values in Silverdale had increased over the period, at least as fast as would be expected in an urban location.

The average land values per hectare in each use category were estimated for each year from 1995 to 2009 using the QV database. However, there had been rapid change in land use in the CAU Silverdale North between 2005 and 2009 – an addition of 75 hectares of commercial vacant properties, as well as increases in industrial mixed-use properties (42 hectares) and residential properties (200 hectares). We suspected these latter two categories also contained a substantial share of vacant properties, but we could not verify this or ascertain its extent from our existing datasets. The average land values had moved around in these categories and would require investigation to arrive at reasonable representation of the land value changes.

For these reasons, we show the changes in land values in the CAU Silverdale South, where the nature of the properties had stayed consistent over the period.

Figure 11.16 Average land values ($'000 per hectare), main land uses in Silverdale South

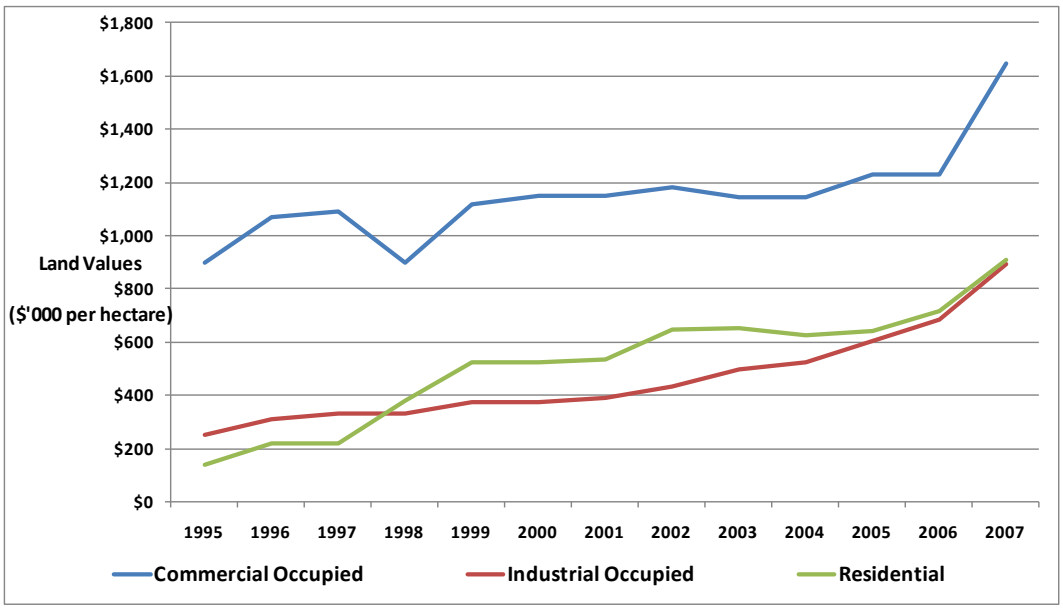


Table 11.17 Average land values ($'000 per hectare), main land uses in Silverdale South (BERL 2011)

	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
Commercial occupied	$900	$1072	$1092	$900	$1121	$1152	$1152	$1180	$1146	$1146	$1229	$1230	$1649
Industrial occupied	$250	$311	$332	$334	$376	$378	$392	$432	$500	$527	$606	$684	$896
Residential	$142	$220	$222	$383	$527	$527	$535	$650	$655	$629	$644	$715	$908

In the period 1995–97, the value of the occupied industrial land was steadily increasing and was higher than the value of residential land. In 1997–99, more land was required for property developments for residential and industrial use. This competition appears to have bid up the price of residential land above that for industrial land. With growth in demand in both land uses, the competition appears to have resulted in a very similar average price in both uses by the period 2006–07.

The commercial land recorded here was a much smaller area than that for the industrial or residential land, with each property being smaller. The commercial land began with a higher value per hectare and largely retained that margin.

11.11.2 Silverdale land value comparisons with the rest of New Zealand

Taking the residential and industrial values per hectare from the two Silverdale CAUs, we compared the value increases between 1996 and 2006 with the increase in values of all urban CAUs in New Zealand. The New Zealand CAUs were classified as 'Less urban' and 'More urban' by BERL in another piece of research (Sanderson 2006). The land prices per hectare have been converted to an index of the value in 1996 = 1000.

The relative changes in values can be seen in the following table.

Table 11.18 Land value changes 1996–2006

Land value index 1996 = 1000	1996	2001	2006
Residential land value			
Silverdale South	1000	2435	3252
Silverdale North	1000	1760	736
Census 'Less urban' CAUs	*1000*	*1720*	*3150*
Census 'More urban' CAUs	*1000*	2040	*3917*
Industrial land value			
Silverdale South	1000	1262	2200
Census 'Less urban' CAUs	*1000*	*1426*	*2696*
Census 'More urban' CAUs	*1000*	*1475*	*3573*

The price index for residential land in Silverdale South increased from 1000 in 1996 to 2435 in 2001. This was similar to the increase in the index for all of the 'More urban' CAUs that increased from 1000 in 1996 to 2040 in 2001. Over the next five years, residential land value in Silverdale South increased at a lower rate than for the 'More urban' CAUs, finishing the period with an index closer to that for the 'Less urban' CAUs.

The small amount of residential land in Silverdale North had a value index that tracked close to the one for 'Less urban' CAUs in the period 1996–2001. In the next five-year period, the price recorded became meaningless, as large areas of vacant land were developed.

The price index for industrial land in Silverdale South increased by less than the average for all urban CAUs. This is probably because the expansion of industrial land areas in Silverdale meant that land value increases had to be restrained in the first instance to attract the industries to occupy them.

11.11.3 Productivity and household incomes

In studies of benefits from transport investments, increases in real incomes can be used as a proxy for increases in productivity, by assuming that income reflects the marginal productivity of workers (Lewis and Stillman 2005).

Our database of census data did not have all of the specific data to estimate the personal incomes of the usually resident population in the CAUs. We were able to make a close estimation of average personal income, and inflation-adjusted those figures to express them in 2006 dollars income per annum. These figures are shown in the bottom row of the following table.

There was a minor increase in average income (3.6%) from $24,071 per annum in 1996 to $24,934 per annum in 2001. However in the next five years the average real personal incomes increased by 21.6% to $30,310 in 2006. Thus the increase in the average real personal income in Silverdale between 1996 and 2006 was $6239 per annum, or 25.9%. Most of this increase was achieved in the second quinquennium, which was after the construction of the motorway interchange.

Table 11.19 Personal and household incomes in Silverdale 1996–2006 (BERL 2011)

Census information	Units	1996	Change	2001	Change	2006	1996 to 2006	
Census households	No.	729	18.5%	864	23.3%	1065	336	46.1%
Average household income	$ p.a.	$41,467	21.6%	$50,424	31.0%	$66,073	$24,605	59.3%
All households' income	$ million p.a.	$30.2	44.1%	$43.6	61.5%	$70.4	$40.1	132.8%
All households' income	2006 $ mn *	$41.9	17.9%	$49.4	42.4%	$70.4	$28.5	68.0%
Average household income	2006 $ p.a. *	$57,463	-0.5%	$57,186	15.5%	$66,073	$8,610	15.0%
Average personal incomes (Est)	*2006 $ p.a. **	*$24,071*	*3.6%*	*$24,934*	*21.6%*	*$30,310*	*$6,239*	*25.9%*

* Inflation adjusted to 2006 values using the CPI.

There is, therefore, an *a priori* case for believing that productivity increased following the construction of the motorway interchange.

The other measure of income from the census was household income. The changes in the average household income expressed in 2006 dollars followed the general pattern shown in the personal income figures. The fact that household incomes were larger reflects the fact that there were multiple earners in the households.

The total of all households' incomes in the area was a measure of the contribution that the residents of the Silverdale area made to the economy. It took into account the income/productivity of individuals, the labour force participation rate of the individuals in the households, and the change in the number of households in the area.

Taking all of these factors together, the 'All households' real (2006 dollars) income from the area was $41.9 million per annum in 1996. The increase in households led to an increase in total household income to $49.4 million per annum in 2001. Between 2001 and 2006 there was then a substantial increase in both household numbers, and real incomes per household, so that 'All households' real income in 2006 totalled $70.4 million. That is, after completion of the Silverdale Motorway Interchange, there was an increase in annual real household income of $21 million in the study area. If the future stream of this income increase was capitalised to the present, with a discount rate of 8%, the present value would be about $250 million.

As an order-of-magnitude, we presume this to be significantly greater than the investment in the interchange. There will be some component of this $250 million figure that is a displacement effect, but in a region like Auckland with a growing population, a very significant part is expected to be additional.

11.12 Step 9: Linking changes in Silverdale to effects in the wider geographic area

It may not be possible to provide a conclusive explanation of the relative importance of all factors driving the structural employment changes in Silverdale; however, there is further evidence that suggests one plausible contributory factor and a role for the motorway interchange.

The data confirmed that employment growth in Silverdale was driven strongly by activity in what is termed 'Group 1' or 'land-extensive' activities. These industrial activities tended to require large sites with relatively low land values, but also tended to be relatively transport intensive and so require reasonable access to the roading network.

During the study period, land for additional Group 1 activities in the North Shore area essentially became unavailable as the area ran out of greenfield land for commercial purposes. This process was exacerbated by the zoning applied to the Rosedale industrial area, which also allowed commercial activities. The demand for land from these more service-oriented activities quickly increased land values in the area to a point where new industrial activity was completely displaced.

At the same time, RDC (2010b, p6) noted:

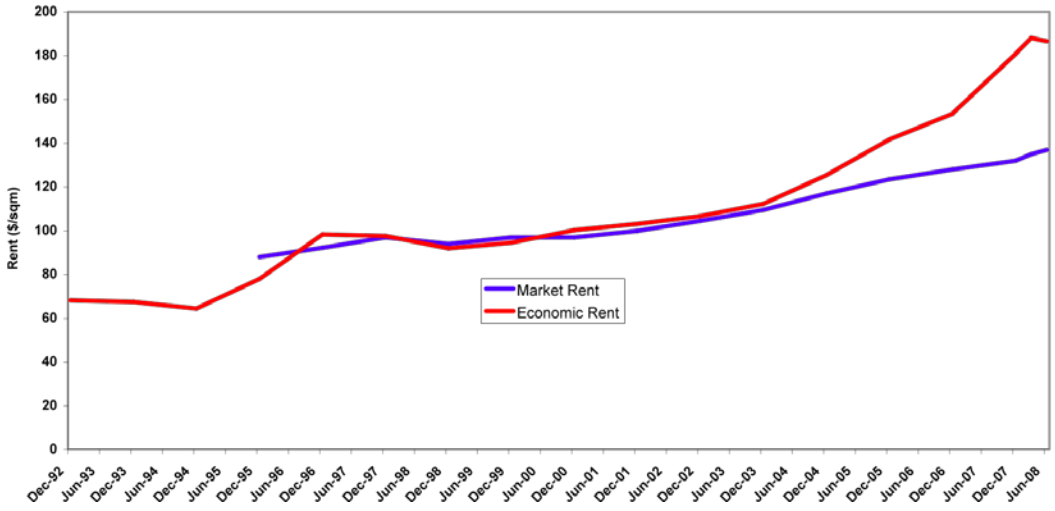
> *... while it is relatively straightforward for retail and office activities to intensify their land use patterns, it is more complex for industrial activities. These are usually land extensive and have economic imperatives that higher densities may not align with.*

Secondary data and information confirming this can be found in various research reports produced by commercial real estate agents. For example, previous research undertaken for the Auckland Regional Council by CBRE Ltd (2008) illustrated the feasibility of property development for industrial versus office uses in the North Harbour (Rosedale) area between 1992 and 2008. The charts compared economic rents (the rental required to support new development based on the end value of the development, land prices and development costs) and market rent (the market rental applicable for industrial and office development). The analysis confirmed that after 1994, market rents for industrial uses in the area fell below economic rents for industrial development, making it increasingly uneconomic to develop sites for industrial uses. At the same time, office development in the area was becoming highly profitable – 2003 market rents for office developments increased well in excess of economic rents.

The implications of these charts are reflected in the actual development patterns of the area. Between 2002 and 2006, over 60,000sq m of office space was built in this industrial area. This was more than the rest of the North Shore combined, and compared with less than 20,000sq m of office space developed in the commercial area of Albany City. Meanwhile industrial activity that could have located here had been priced out of the North Shore area.

Figure 11.17 North Harbour office development – market v economic rent (CBRE Ltd 2008)

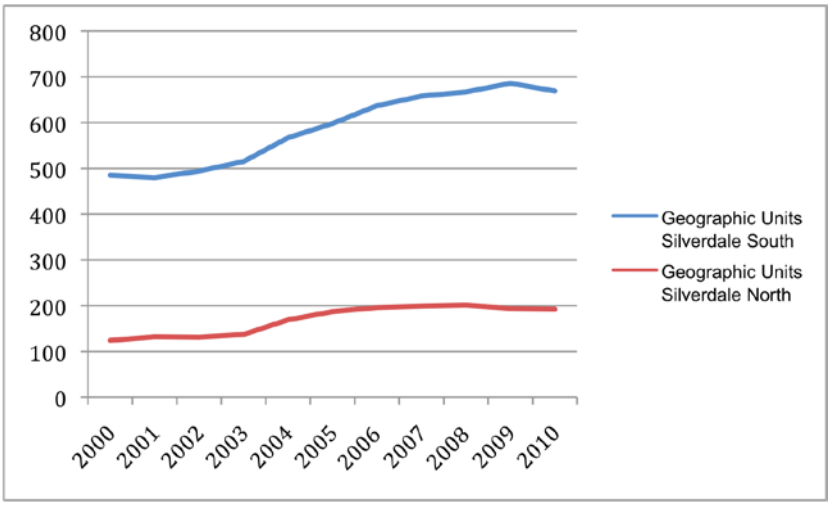
Figure 11.18 North Harbour industrial development – market v economic rent (CBRE Ltd 2008)



These displaced activities needed to find alternative locations. With its supportive zoning, Silverdale South could be a likely choice. The key to this choice would be accessibility and with the interchange providing access to the Northern Motorway, Silverdale South was only 10 minutes from the Constellation Drive interchange and access to Rosedale. This may explain how the interchange helped to shape the observed land use changes within the study area.

One way of exploring whether there had been a relocation of industrial activity to the study was to hypothesise that this would be reflected in an increase in the number of firms undertaking these activities. Again using SNZ's Business demographic data ('Employment-size groups for geographic units'), we examined changes in firm numbers (geographic unit counts), by ANZSIC group, down to the area unit level, between 2000 and 2010. The first graph charts the number of firms (geographic units) in all sectors in the two CAUs. It shows a noticeable (40%) increase in the number of firms in Silverdale South between 2005 and 2009.

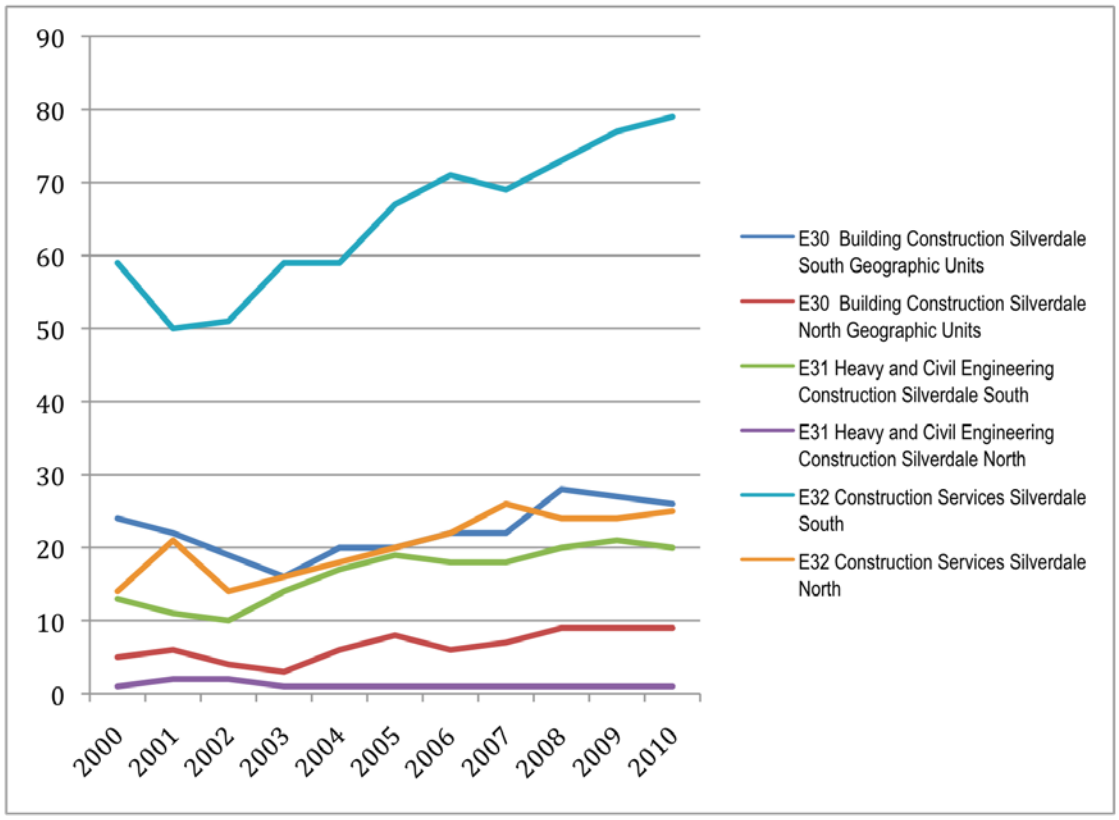
Figure 11.19 Firms (geographic units) – all sectors Silverdale CAUs



Next we looked at the changes in firm numbers in the construction sector, at the 2-digit level. The data revealed that construction services firms in Silverdale South had grown most strongly and were also the

most prevalent. There had also been lesser but consistent growth in firms within all subsectors in both CAUs, with the exception of heavy and civil engineering in Silverdale North.

Figure 11.20 Construction firms (geographic units) – 2-digit Silverdale CAUs



The analysis suggested that the increase in employment in these two CAUs, and in construction activities, was accompanied by increasing numbers of firms, which does support the hypothesis suggested.

Further analysis of other sectors, notably manufacturing, could also have been beneficial (but was not undertaken). This could have supported (but not proved) our hypothesis that increasing firm numbers would be consistent with a relocation of activity.

11.13 Step 10: Overall assessment – the changing urban nature of Silverdale

The property data for Silverdale over the period 1995–2009 showed that with the opening of the motorway interchange, the nature of industry employment changed, and so did the range of urban services and facilities in the new, growing town.

Local industry was initially almost exclusively light industry, but after the interchange opened, one or two heavy industries located here. With the growing number of light industries, industrial services businesses also opened, one in 1999, growing to six by 2009. The number of commercial office properties increased from one to four, and late in the period, a number of warehouse/distribution facilities were opened.

Social services grew, with the first recorded education facility opening in 1999. The first religious property was designated in 2003, and a second in 2008. There were already four properties used for sport and recreation in 1995, and this grew steadily to eight properties by 2009.

An important observation is that the accessibility effect of the interchange was probably two-fold. Within Silverdale, improved accessibility to the North Shore, combined with an availability of land zoned for industrial purposes, probably contributed to the strong growth in industrial activity in Silverdale South. The area provided a good alternative to the North Shore for these activities, as zoning rules and rising land values in North Shore had essentially curtailed future industrial development.

On the other hand, the rising population in the study area was accompanied by an increase in traffic travelling away from the study area in peak hours. The interchange was providing Silverdale and Whangaparaoa residents with increased access to employment opportunities in the North Shore and other parts of Auckland, including the CBD.

From a timing perspective, as would be expected a clear lag existed between land use changes and employment changes. For commercial activities, industrial transformation occurred first, with retail following. At the time of this research, growth in services had not really materialised, even though zoning for a 'knowledge economy' area was in place. Population growth had lagged employment growth.

The observed changes in property land use show quite clearly that there had been a transformation and increased diversity of facilities and services available to the residents and businesses located in Silverdale. Silverdale had graduated at least one rung up the settlement hierarchy, following the construction of an interchange that gave increased access to the motorway and the rest of the Auckland region.

12 Extending the approach – quantitative analysis via incremental improvement

We next considered how to achieve a process of incremental improvement of information over time, to allow increased quantification of results as more data is collected via post-project evaluations. The BERL regression tool was used to advance this aspect of the approach.

12.1 Regression tool

At the time of this research, BERL was developing a regression tool to provide coefficients of relationships between and among the main parameters driving behaviour in evolving urban economies in New Zealand. The tool could be used to indicate the likely coefficients of the main economic variables consequent on transport and integrated urban development investments that result in a predictable transformation of urban form, pattern and behaviour.

12.2 Urban parameters being analysed

The main parameters that have been utilised in the empirical comparative observations of coefficients in BERL analyses over recent years have been urban density (resident and workplace employment); land use and land value and the related industry profile of employment; transport mode usage, particularly PT and AM; and productivity and labour force participation rates. At the time of writing, BERL, in conjunction with Opus Central Laboratories, was analysing the coefficients of the relationships between and among most of these parameters in a project funded by FoRST.

The productivity aspect was not being specifically researched, but instead was taken to be indicated by the industry profile of employment and the national average productivity per employee in each industry. Labour force participation rate behaviour was not specifically being researched.

The coefficients were being measured using multiple regression analysis on a dataset of the 1054 CAUs in New Zealand that had been identified as of mainly urban character. The main data was from SNZ, and originated from three censuses – 1996, 2001 and 2006.

The land value data was from QVNZ and while the main years of interest for this data were 1996, 2001 and 2006, the available data was for the years 1995–2009, again at CAU level. As well as the total land value for land used in each of 42 land uses in each CAU, the QVNZ data also showed the total area of land employed in each use and the number of properties employed in each use. This database thus allowed an estimation of average land area per property in each use, and average land value per property and per hectare in each land use, in each CAU for each year from 1995 to 2009.

There were opportunities to obtain order-of-magnitude checks between the SNZ and QVNZ databases in each census year by, for example, comparing the number of households in the census data with the number of residential properties in the QVNZ data.

While this work was at an early stage, there were encouraging signs of reasonably robust coefficients being generated for such aspects as the relationship between urban density, industry employment profile, land values, and PT mode usage. Overall, the set of drivers of land values and land usage between 1996

and 2006 had remained consistent. Initial econometric analysis suggested that the effects of the main explanatory variables strengthened between 1996 and 2006; ie the estimated coefficients were larger for later time periods.

A key insight of the empirical analysis was that residential and employment density appeared to be strongly associated with the value of both residential and commercial land. This indicated that the form of the urban centre could have a powerful effect on the value of the land, regardless of the use of the land. Further work is required to establish whether urban form drives land values, or whether there is a contingent, multi-directional relationship. The results so far have suggested the following four implications for key stakeholders:

- Specialisation of locations – inner urban centres tend to be highly specialised, with a significant amount of high-density residential land surrounding, or close to, high-density commercial land.
- Encouragement of higher urban density – higher population density is associated with higher residential land values and land usage in urban centres, which tends to correspond to access to commercial areas and good local amenities.
- Improved access for more workers – areas with higher employment densities are associated with higher commercial and industrial land value and land usage.
- Use of PT – the relationship between access to PT and land value is complex and requires further research. Understanding the relationship between residential/employment location and PT use choices will help local authorities and planners design systems and urban forms that maximise settlement liveability, well-being and economic prosperity.

12.3 Advantages and opportunities

One of the main advantages of the BERL tool is that once the expected land use impact of a transport and integrated urban development investment is known, the further analyses of the future shape of the affected area's economy and land values can be estimated from existing, 'official' databases, such as the SNZ and QV databases manipulated for this purpose by BERL.

There is the proviso above, which is that the future land use can be predicted. The ability to do this will improve over time, as the coefficients from the regression tool are applied over time to case studies of a range of transport and urban development investments.

One example has been given above in relation to the impacts of motorway interchange construction exemplified in Silverdale. We note that Pugh's (2005) study of the industrial impact on southern Staffordshire of the M6 Toll found predictable impacts of an interchange on industrial development. The changes observed at Silverdale seem to be similar to those analysed by Pugh. More detailed survey and analysis of the changes at Silverdale could provide coefficients that could potentially be applied in New Zealand. With such coefficients, the initial, high-level strategic analysis of future proposed interchanges could be analysed using the databases of this BERL tool.

The Pugh coefficients have already been used, with some caution, in a New Zealand study (Sanderson and Arcus 2007) to estimate the likely comparative impacts of different interchange configurations. For their study, adjustments were made to the Pugh coefficients and applied to the hinterlands of the various interchange options using GIS.

The generation of New Zealand coefficients by progressive investigation of the Silverdale interchange and, in future, other interchanges and other transport investments, will, over time, strengthen the ability to obtain good order-of-magnitude estimates of the likely impacts of transport investments. These impacts will be estimated using readily accessible data, and will provide high-level strategic selection of investment options.

13 Performance of the case study approach

To complete the process, we next evaluated how the case study tool had worked in practice, based on the process followed in section 11. We investigated the usefulness of the approach in helping to establish the effects that the chosen transport investment had had on land use, land values and productivity in the study area, and whether these results could be transferable.

13.1 Effects on land use

The approach provided a triangulated approach to this aspect of the analysis by combining QVNZ information on land use, SNZ business demographic data, and planning information.

The result was a comprehensive descriptive analysis of the land use changes that had occurred within the case study area from the pre-project starting point to the time of this research. This data was readily available and free where sourced from SNZ. The richness of the analysis provided a deep insight into the nature and timing of land use change in the area, of how this related to zoning provisions that applied in the area, and the relationship between the changes in the study area and other parts of the region.

13.2 Effects on land values

The relationship between changes in land values and changes in land use patterns (or vice versa) was provided at a descriptive level, with the expectation that the extension into the quantitative analysis would provide more rigour. Nevertheless, in combination with the depth of data available at the contextual level it was possible to conclude that observed changes in land values were reflecting the opportunities offered by a combination of accessibility and zoning.

The extent to which changes in land values can be attributed to the specific effects of transport investments is something that a quantitative analysis would be designed to address in a rigorous way.

13.3 Effects on productivity

One way in which productivity effects can be discerned from the qualitative analysis is through the assessment of the changes in employment and sectoral composition within the case study area. We had sufficient information to assess the output potential from the area over time, and therefore the capability of assessing productivity changes.

We note that in our process of developing this tool with the steering group there was an understanding that the qualitative tool would be more capable of providing insights into land use effects first, which could then be further interpreted to assist in revealing productivity effects. At the next stage of the analysis, the regression tool could be developed to assess the extent to which land values reflect these productivity changes.

13.4 Transferability

Successful transferability of the results of the case study to future projects is key to the success of this tool. The research and analysis strongly suggests that the choice of case study will be important in this regards, with as a close an approximation of the future project situation required. However, the richness of the contextual analysis is also a key aspect. This richness will help analysts and planners to fully understand the compatibility between case study and project, where differences may be important and where there are strong grounds to accept the transferability of information.

In addition, it is important to recognise that undertaking a series of case studies and adopting an approach of routinely monitoring the indicators we have identified before, during and after the development of transformational transport investments will be a further key step in the development of a genuinely comprehensive database and understanding of the effects of different transport investments in different locations.

13.5 Improving value for money

One of the objectives of this study was to assist transport infrastructure providers in gaining greater value for money from future transport investment. The NZTA *Planning, programming and funding manual* (PPFM) (2008, pA1-8) notes that when assessing strategies, programmes, packages and projects, the Government Policy Statement (GPS) requires both the NZTA and local government to consider achieving value for money. The Land Transport Management Act 2003, s25(1) and s96(1)(b), also requires the NZTA to use its revenue in a manner that seeks value for money (NZTA 2011).

There is no general definition of value for money that is used by all transport infrastructure providers. In the most recent State Highway Strategy (NZTA 2011), value for money is defined as functional performance in relation to resources consumed.

A more complete definition is also provided by NZTA within the PPFM (2008, pA1-8), including the expectation that:

> *... value for money outcomes are identified first through the selection of activities that make the largest contribution for the funds invested towards achieving the GPS impacts and the wider objectives of the LTMA and NZTS.* [15]

The two main elements of the PPFM definition of value for money are as follows:

- Value for money, in general, means selecting the right things to do, implementing them in the right way, at the right time and for the right price.
- Determining value for money requires taking a long-term view of the total value for money attributable to an activity and not simply the initial capital cost – a whole-of-life assessment will consider the

15 The PPFM notes that 'The assessment framework shows how the NZTA's strategic investment direction will be implemented while ensuring value for money when selecting activities for inclusion in the NLTP. Activities proposed for inclusion in the NLTP will be assessed against 'strategic fit', 'effectiveness' and 'economic efficiency' to determine the right time for implementation and their relative priority for funding. The assessment criteria reflect the NZTA's strategic investment direction.'

social, environmental and economic impact of the outputs, any ongoing maintenance and operation costs of the asset or service, and costs associated with its disposal.

There is an important difference between these two elements. The first point recognises the importance of making well-informed investment decisions. The second point focuses on ensuring that once strategic investment decisions have been made, all relevant costs are then taken into consideration. Our approach is intended to help transport infrastructure providers make more informed strategic decisions that will contribute to the first element, in particular selecting the right thing to do.

As explained in the introduction, the key output from the project was an economic impact assessment tool or framework that would provide a way of evaluating projects before being put through the EEM process. This was viewed as the best approach to support integrated land use and transport planning as an early assessment of a project prior to the full EEM evaluation, and would be more likely to lead to changes in the scope or priority of projects to support better economic and land use outcomes. Correspondingly, our focus has been on developing a broad, qualitative impact assessment tool to inform high-level investment and purchasing decisions at an early stage in the development of a project. This is intended to support a more strategic approach to funding allocation.

The key question is whether this approach can assist transport infrastructure providers to make better investment decisions. The first important point is that transport is an enabler of outcomes, not the outcome itself, and a substantial component of the end result of transport investment is likely to be reflected in land use changes that are responses to new economic opportunities. Therefore, an understanding of the ways in which land uses have changed, as a result of comparable projects, is a good way of developing an initial understanding of the potential for a proposed project to act as an enabler of land use and productivity change.

The second key point is that the comparable data providing an indication of land use change will also be able provide insights into the reasons for these changes, and in particular, the role of the comparable transport project or projects used as case studies. By linking the understanding of how and why land uses changed as a result of these case studies, it will be possible to then interrogate a new project proposal with some rigour to determine:

- what the likely land use changes could be
- how these fit with existing planning aspirations
- whether there might be possible early modifications to a scheme that would make it more successful in delivering the desired land use outcomes.

In this sense, the tool we are proposing is designed to assist in achieving better value for money from transport investments through assisting in selecting the right things to do, implementing them in the right way, at the right time.

It is important to recognise that this approach is expected to be applied at an early stage in the development of a project – the earlier this information is available, the greater the potential to make modifications to a project to ensure that the intended (transformational) outcomes can be achieved. It is therefore a tool that can be usefully be applied to project optimisation.

As the case study approach can easily be replicated, this process can begin immediately, with application to existing transformational projects that are in the process of initial development. The advantage of

starting now would be that over time, much richer data would be gathered and available for new assessments.

13.6 Overall performance

Overall, the case study approach, focusing on a broad range of indicators to supplement information on land values, appeared to be a useful starting point in the assessment of land use changes arising from a transformational transport investment, whilst also providing some indication of the productivity benefits at the local (micro) level. Extending into a quantitative analysis, using a regression tool that can work interactively with the qualitative findings, would add greater rigour and also predictive power over time.

In section 9 we noted that we would use the key attributes of the approach (as set out in table 9.1) to assist in understanding the performance of the case study approach. The following table sets a high-level assessment of the fit between the qualitative approach developed and these attributes.

Table 13.1 Assessment against key attributes

High-level consideration	Disaggregated attributes	Does the case study tool allow this?
Timing of effects	Treatment of time – ability to capture effects before, during and after construction	Yes – property value, land use, business demographic and population data all available for the required time frame.
	Ability to be applied ex ante	Transferability from observed data to *ex ante* prediction is possible so long as care and judgement are exercised. The choice of case study will be important. Undertaking a series of case studies and adopting an approach of monitoring changes before, during and after the development of transformational transport investments will be important. Combining the predictive potential of the regression tool with the qualitative richness of the broader indicators will help to enhance the understanding of specific drivers of change at the case study level and this can be used to help assess the applicability of predictions within the new project area.
Attribution of effects	Extent to which drivers of changes in land values can be accurately identified and quantified	At the qualitative level, the richness of the data assessing land use changes provides a sound base from which the quantification of drivers of land value change can then be undertaken using the regression tool. Ultimately, assuming the case study analysis is undertaken and the quantitative tool developed, then the combined qualitative and quantitative approach will be expected to provide a rigorous assessment of the drivers of land values.
	Ability to account for other contextual variables that may impact upon the land values	A key purpose of the qualitative analysis is to assist in developing an understanding of the importance of contextual variables.
	Extent to which values can be attributed to the specific effects of transport investments	Whereas the qualitative tool is a useful starting point for describing land use changes, attribution of values to specific transport investments will be a function of the regression model.
Ability to be applied to location	Adequate catchment area	The tests we have run so far indicate that the approach we have developed can easily be applied within a desired area.

High-level consideration	Disaggregated attributes	Does the case study tool allow this?
Cost and complexity	Ability to use existing data	All information used in the case study was sourced from existing datasets.
	Ability to use quantitative and qualitative information	A key outcome of this investigation was the recommendation of a staged development process that will deliver a tool capable of combining qualitative and quantitative analysis.
	Ability to develop to become more forward-looking over time	Staged development of the assessment tool, leading to the introduction of a regression model, combined with the undertaking of case study appraisals to generate a comprehensive knowledge and database, will, in time, lead to the development of a more forward-looking tool.
Reliability	Ability to translate changes in land values into effects on land use patterns	The combination of qualitative, contextual and quantitative data will be a key here.
	Ability to reliably transfer data to other project applications	Over time, as case studies are developed and the method is tested more fully, we see this a real possibility. Testing on actual projects will be necessary to determine the extent to which this is possible and where adjustments might make this transferability more accurate.

PART 4: IMPLEMENTATION, CONCLUSIONS AND RECOMMENDATIONS

14 Implementation of the approach

We now consider the effective integration of the preferred approach into current evaluation processes. Further consideration is still needed to determine how to encourage other transport infrastructure providers to adopt this type of approach.

14.1 Fit within the planning framework

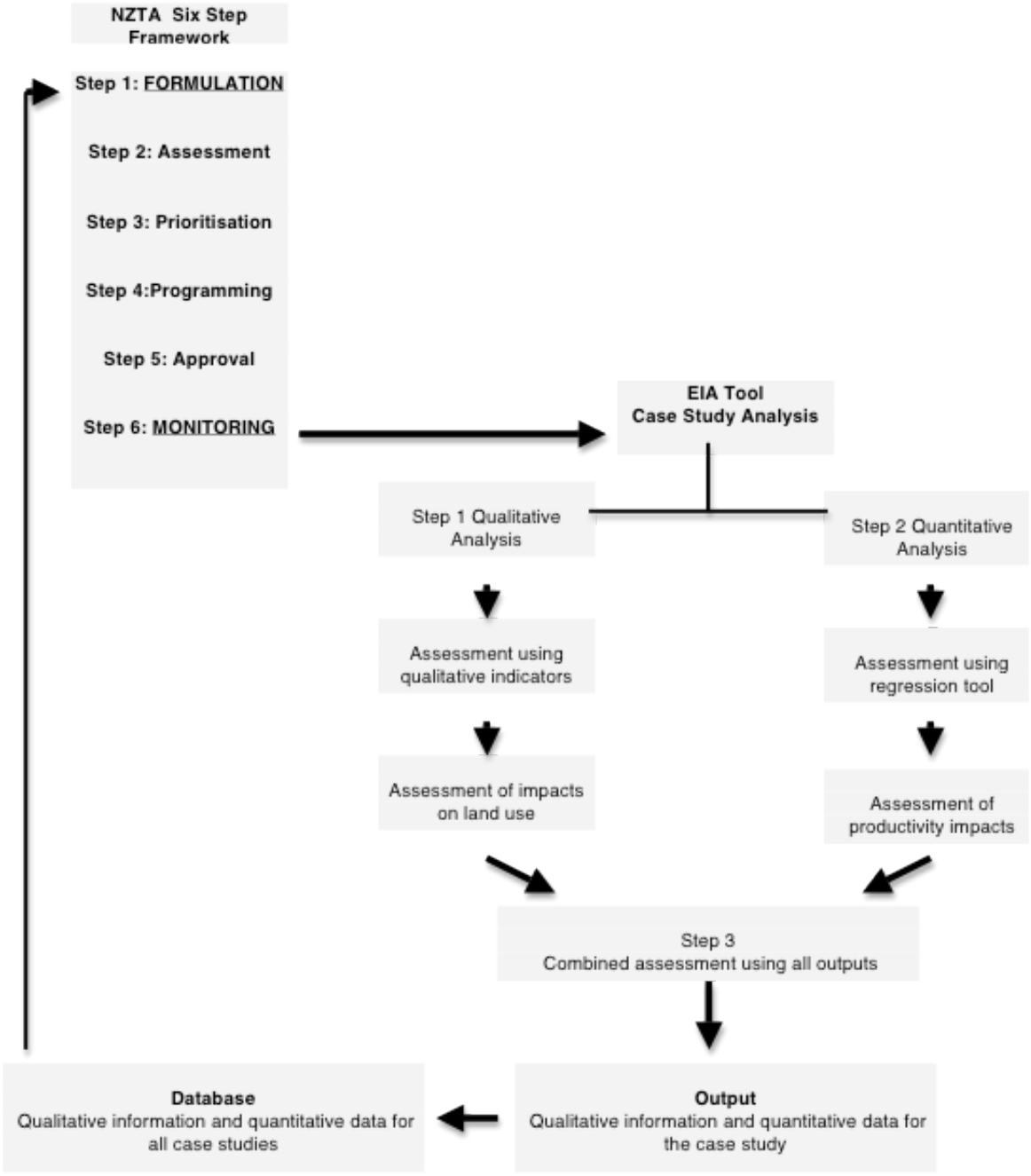
The implementation of this methodology will require a structured approach to the use of the tool in a project assessment and to the collection of data in a way that supports the use and development of the tool over time. These two aspects have a degree of overlap between them, and require:

1 a structured assessment process for the economic impact assessment tool to be used for projects

2 a structured monitoring process to support the development of the supporting database.

The following diagram explains how this process fits within the existing NZTA six-step process (as set out in the PPFM), and how the feedback is captured between monitoring and project formulation.

Figure 14.1 Fit within NZTA's six-step process



The following section identifies where each step fits within the current NZTA planning framework, and then explains the way in which the tool can be translated into an operative methodology.

14.2 The assessment tool

The intention of this research has been to add to the development of a more strategic approach to funding allocation. Ideally this will assist in gaining greater value for money from future transport investments.

We have approached this through the investigation of an economic impact assessment tool that provides a way of evaluating projects *before* being put through the EEM process.

This pre-EEM focus was seen to be the best approach to enable or support integrated land use and transport planning – an early assessment of a project (prior to the full EEM evaluation) was thought to be the most likely to lead to changes in the scope or priority of projects to support better economic and land use outcomes. This approach was therefore consistent with the aim of better integrating transport and land use planning decisions.

In terms of the NZTA six-stage approach to planning, programming and funding (set out in the PPFM), the approach we are proposing could be applied either during Stage 1 (Formulation) or early in Stage 2 (Assessment). Although this is technically an assessment tool, there are good reasons for recommending undertaking this assessment at the formulation stage. Firstly, we believe this early intervention using a broad, qualitative, impact assessment tool prior to the EEM process is the best approach in informing high-level investment and purchasing decisions at an early stage in the development of a project, in order to support a more strategic approach to funding allocation.

Secondly, by carrying out this step at the formulation stage there is a clear separation from the EEM evaluation. The latter addresses issues of overlap and double-counting between the wider economic benefits being estimated, using meso-level techniques within the EEM and using land values and other local micro-level indicators to disentangle the complex range of economic relationships and effects that are at play in urban areas.

There is also the possibility that an improved understanding of the observed changes in land use following transformational transport investments will assist in translating monetised estimates of wider economic impacts into actual effects 'on the ground'.

14.3 Building the database

Building the database will require a resource commitment, but could be integrated into the monitoring and review of funded activities, undertaken as a part of obligations under the Land Transport Management Act 2003. This process includes post-implementation reviews that can be carried out up to 10 years after completion of an activity. These reviews audit a sample of completed large construction projects (split 50:50 between state highway and local authority projects) against the initial project objectives, costs and economic justification. It is our view that consideration should be given to expanding this process in order to accommodate the data collection required to develop the supporting data base.

The constraint to developing the initial database is simply a resourcing issue. As noted, there are a reasonable number of transformational projects that could be analysed to form an initial database. The analysis of new projects can obviously only take place over a longer time frame, but integrating into the monitoring process will assist this. In addition, a project proponent may wish to choose a case study that has not previously been analysed, and this information could then be added to the database.

14.4 Translating the case study tool into a working methodology

In this section we explain briefly how the qualitative analysis might be translated into a working methodology. This is only an initial suggestion and we recommend that this could be adapted to fit effectively within the planning framework.

The table below identifies a process for undertaking a qualitative case study to guide application of the methodology to a project. The table also explains how the data might be analysed and how the results might be interpreted by transport agencies. Before undertaking this process, agreement should be reached on whether the proposed project is likely to be sufficiently transformational to warrant this assessment.

The first step asks if the project being proposed is transformational – that is, whether it will bring about (or be capable of bringing about) significant changes in land use and economic performance, regardless of the scale of financial investment. Where there is an expectation that significant benefits from the project will arise through transformational outcomes, or where there is a concern that land use or economic impacts may be significant but not well understood, it is advisable to adopt this approach at an early stage. The main benefit of this will be the potential for a more integrated transport solution that best supports local land use and economic development. If a project is deemed to be transformational, then the following process can be applied.

Figure 14.2 Qualitative assessment methodology

Step 1: Identify appropriate case study project/area(s).

- Does the case study provide similar levels of accessibility as the proposed project? Compare the proposed project's forecast traffic volumes and patronage to those of the proposed case study area.
- Is the pre-project pattern of land use observed in the case study similar to the areas of the proposed project?
- Are there any other factors that either indicate the case study is likely to be a good or bad comparator? Consider other useful indicators such as proximity to other commercial, industrial or residential areas, proximity to other transport, etc.
- Confirm the applicability of the case study chosen.

▼

Step 2: Develop a baseline profile of the case study area prior to the case study project.

- Using Statistics NZ and Quotable Value NZ data, assess the land use patterns for residential, commercial and industrial activity, and the economic structure of the case study area, at the pre-project stage. Using Statistics NZ data, assess employment by sector, CAU or meshblock level. Using Quotable Value NZ data, assess land values by CAU for residential, commercial and industrial uses.
- Identify any other relevant land use or economic characteristics of the project areas pre-project.
- A key step in assisting this process will be to assemble the supporting database derived from case studies and from the re-examination of completed projects (an example of this is shown in section 11 of this report).

▼

Step 3: Establish planning context/zonings applying to the case study area.

- Review key regional and local planning information to determine the planning context that has applied to the project area, both before implementation and onwards to the present date. Information will be contained in

some or all of regional growth management plans, district plans, local plans (eg centre plans or masterplans), and private plan changes.

- Note whether there appears to be a lead or lag between planning changes and the project. Does the case study project appear to be a response to future planned growth? Or is the case study project a response to growth that has already occurred?
- Identify, if possible, whether land use outcomes have been consistent with expectations or whether un-anticipated consequences have occurred. Note what these were. Does the resulting land use reflect what was anticipated, or has the project led to a different pattern of growth from that initially planned for? What differences can be observed? Why?
- Use this information to consider how the planning context around the proposed project might support or hinder development, and what risks there might be to achieving desired outcomes.

▼

Step 4: Travel patterns and accessibility analysis.

- Assess traffic volumes, using monitoring data from local sites and establish the presence of any clear patterns that relate to the project and to land use changes.
- Assess patronage data and establish the presence of any clear patterns that relate to the project and to land use changes.
- Compare with projections used at the project investigation stage, if available.

▼

Step 5: Examine residential land use, population and dwellings changes over time (census data).

- Using census data, establish changes in population at the CAU level, looking at population composition, patterns of household composition, and household demographics such as income. Investigate whether income changes may be related to changes in the productivity of the area or changes in the levels of access to other employment areas.
- It is relatively easy to supplement this analysis using Statistics NZ census data, using the dataset 'Occupied dwelling count for area units' in the relevant council area for 1996, 2001 and 2006.

▼

Step 6: Ascertain industrial land use changes over time, using the Quotable Value NZ property database.

- The Quotable Value NZ property data shows the industrial land that is occupied and that which is vacant. This provides a good insight into development patterns and take-up rates for land, which can be compared with the timing of the transport changes.

▼

Step 7: Examine changes in economic structure over time, using employment and firm data.

- Statistics NZ's business demographic datasets (eg 'Detailed industry by region for geographic units') are used to examine the economic structure of the area and changes in its composition over time. These datasets provide a high level of detail, by sector, at the area unit level.
- Examine employment changes, by sector, over time, for the CAUs.
- Compare changes with other areas and trends.
- Using disaggregated sectoral data, identify the more precise nature of employment changes if necessary.
- Report how the area's economic structure has changed before and after completion of the project, and consider how this reflects prior expectations (if possible). Consider what this might imply for the area's productivity growth.

▼

Step 8: Land value and productivity changes over time – property database and census income data.

- Using census data for the resident population, increases in real incomes can be used as a proxy for increases in productivity, although this may reflect changes in access to other areas of employment.
- Using Quotable Value NZ data on land values for commercial and industrial land can lead to an understanding of changes in the value that firms are placing on land in the area. This can be used as a proxy for productivity changes, prior to a more sophisticated regression analysis. Understanding these changes in value in relation to broader changes in values (say at the district, city and/or regional level) will help to generate more confidence around the reliability of estimates.

▼

Step 9: Consider relationships with the wider geographical area.

- Putting the changes observed in the case study area into a wider geographical perspective may reveal important impacts. There are no precise ways of identifying likely locations in advance, and this should be done on a case-by-case basis.
- Good reasons for examining other locations would include proximity, connectivity and similarity in terms of land use.
- An important insight would be whether the case study project and its land use effects in the case study area have been complementary or in conflict with land use patterns and aspirations in these other areas.

▼

Step 10: Outcomes: Summarise all key land use and productivity effects – eg:

- the nature and magnitude of land use changes
- the extent to which these changes can be related to the transport project
- whether the actual transformation of the case study area matched the planning aspirations
- other key insights that will result in the transport project supporting desired land use patterns
- interpretation (by the project proponent)

▼

Step 11: Actions

- **Use this information to inform the formulation of the scheme so that land use change can be better aligned with aspirations and productivity growth can be optimised.**

14.5 Next steps in developing the assessment tool

Once it is decided to proceed with implementation, two key steps are required to further develop the assessment tool:

- gathering comprehensive data at the local level for a range of transformational transport investments through further case studies
- completing the development of the regression tool, in conjunction with the additional case study information and data, to complete the quantitative aspect of the assessment tool.

It is expected that these steps will assist in providing richness and predictive power to this approach. One key point to bear in mind is that whilst it is unusual to reassess project economics after completion, this approach will encourage the ongoing monitoring of projects in order to gather further data. Conveniently, this will be a useful way of assessing the accuracy of the predictions made and will greatly assist in developing and refining the tool so that it becomes more able to predict land use and productivity changes.

14.6 Linkages to other issues

Key linkages that would be worth keeping in mind are:

- the relevance of this approach to value capture questions at the local level
- linkages with spatial planning processes at the local and regional level, and the potential to better inform these processes on the specific and observed relationships between transport and land use changes in New Zealand.

15 Conclusions

The key purpose of this tool is to utilise existing evidence as a basis for estimating the productivity and land use effects of future projects.

In the process of developing this tool, focus was directed towards the identification and testing of a qualitative tool that was capable of providing insights into land use effects and which could then be further interpreted to assist in revealing productivity effects. The next step would be the development of a quantitative regression to provide a more rigorous assessment of productivity changes via changes in land values. The qualitative information from the case studies would also provide contextual explanations for quantitative results.

The key features of the case study tool are as follows:

- It can rely on the analysis of single or multiple case studies where a similar project has already been implemented. Transferability of data to the new situation is the key requirement.
- It derives estimates of effects by comparing 'before' and 'after' conditions, generating a time series comparison. The advantage of this approach is that it allows a picture to be built up of what has been actually happening in response to the project over time.
- It can provide information regarding the nature of changes in surrounding land use following the announcement, building and completion of projects.
- It can be applied to new projects as they are progressing through the formulation stage, so that early monitoring can be undertaken as well as assessment of land use and productivity effects.

Our investigation of a qualitative case study indicated that focusing on a broad range of indicators to supplement information on land values appears to be a useful starting point in the assessment of land use changes arising from a transformational transport investment, whilst also providing some indication of the productivity benefits at the local (micro) level. Extending into a quantitative analysis, using a regression tool that can work interactively with the qualitative findings, would add greater rigour and also predictive power over time.

Overall, our main conclusions from the literature review and consideration of methodologies were as follows:

- The development of a comprehensive assessment tool needs to be viewed as a long-term process, with sensible staging to allow time to refine the approach and collect the necessary data.
- The logical starting point is to begin with the development of a mainly qualitative assessment tool based on a checklist or indicator type of assessment including descriptive statistical analysis.
- The development of a regression-type modelling tool will then allow a more quantified assessment to be added over time.
- The intention is to support the incremental enhancement of information over time to allow increased quantification as more data is collected via post-project evaluations. Post-project monitoring will be a key information source. Monitoring the effects of projects allows feedback to improve forecasting methods using land values.

- The development of a useful indicator tool will therefore require a long-term commitment to gathering data from before, during and after projects, to ensure a reliable approach is developed.
- A long-term view is vital for this process to be successful.

Therefore, it is proposed that the best way to progress is through the development of a case study approach, using qualitative indicators and descriptive statistics as a starting point, prior to the development of a more sophisticated and complementary quantitative model.

A staged approach to development will allow the gradual refinement and quantification of the evaluation tool. A qualitative tool will be useful in the short term and also provides the richness needed to accompany a regression-based quantitative analysis.

Overall, we investigated how it might be possible to get a forward-looking view of the productivity and land use changes associated with transformational transport investments. An important conclusion was that the effective *ex ante* analysis of land use and productivity changes arising from transformational transport investments is critically dependent on the use of *ex post* data in order to reveal actual changes in these factors that can be related to transport investments. The successful implementation of this approach will require a long-term commitment from stakeholders as appropriate to developing a suitably comprehensive database to inform the assessment of appropriate case studies.

In our view, the retrospective case study approach can be used to provide a predictive tool to assess land use and productivity effects of transformational transport investments. One key factor that enables this is that the tool is intended to be employed at the project inception phase. It is not designed to precisely quantify productivity effects in the same way that agglomeration effects are quantified in the EEM. It is more designed to indicate potential directions of changes to land use and productivity, and through these indications, provide feedback that can be used to better align transport investment with desired land use and economic change – but to do this from an informed perspective, based on what has been observed to happen in similar locations where similar projects have been implemented.

In our view there are a number of important questions remaining and there are further steps that could be undertaken to address these issues over time:

- **Improving the ability to separately identify productivity and land use changes due to transport improvement alone:** Successfully disaggregating the various factors contributing to productivity and land use change is an important challenge. The development of a regression tool provides one well-understood means of addressing this issue.
- **The ability to demonstrate the direction of cause and effect between an individual's or firm's choice of location and land value:** A key insight of the empirical analysis is that density appears to be strongly associated with the value of both residential and commercial land. This indicates that the form of the urban centre may have a powerful effect on the value of the land, regardless of the use of the land. Further work is required to establish whether urban form drives land values, or whether there is a contingent, multi-directional relationship.
- **The ability to derive *ex ante* productivity and land use changes from *ex post* data and ensuring the robustness of such analysis:** Our testing of regression tools suggests that there are encouraging signs of reasonably robust coefficients being generated for such aspects as the relationship between urban density, industry employment profile, land values and PT mode usage. However, further testing of the ability to derive *ex ante* productivity and land use changes from ex-post data will be an

important way of validating this approach. Our suggestion is to treat this as a refinement issue once the tool is being used.

- **Interpreting and separating variations in property value due to other factors (eg economic condition, supply and demand forces):** This would be a key next step as part of the development of the regression tool.

16 Recommendations

The main recommendations are as follows:

- Initiate the implementation of the assessment tool at the strategic planning level within the planning and evaluation process.
- Undertake further case studies of transformational transport investments, collecting data over time in order to develop a rich understanding of the local land use and productivity effects they lead to. It is our view that consideration should be given to expanding current monitoring and evaluation processes in order to accommodate the data collection required to develop the supporting database.
- Continue with the development of the quantitative (regression) tool in order to expand the analysis from the qualitative starting point to a fully operational qualitative and quantitative assessment tool.
- Encourage other stakeholder organisations to adopt a more strategic approach to project formulation using this type of methodology.

We will further develop these recommendations in conjunction with stakeholders as appropriate.

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Appendix A Empirical results from the literature

Table A.1 below provides a summary of the results of a number of the more well-known US studies, and table A.2 summarises the European literature:

Table A.1 Summary of results from US literature (Sources: RICS Policy Unit 2002, p8, and GVA Grimley 2004, p67)

Source	Location	Impact of	Impact on	Impact
APTA (2002), Diaz (1999)	North America	Proximity to rail	Residential and commercial property values	In general, positive (via accessibility)
APTA (2002), Weinstein and Clower (1999)	DART (Dallas Area Rapid Transit)	Proximity to DART/LRT	Commercial property	Positive
APTA (2002), Cervero and Duncan (2002)	Santa Clara, California	Proximity to LRT	Commercial land	Positive
APTA (2002), Gruen Gruen + Associates (1997)	Chicago	Proximity to transit	Residential property	Positive
APTA (2002), Armstrong (1994)	Boston	Community with commuter rail station	Residential property	Positive
APTA (2002), Sedway Group (1999)	San Francisco Bay Area	Bay Area rapid Transit (BART)	Residential property and commercial land values	Positive
APTA (2002), Cervero (1994)	Washington and Atlanta	Patronage	Office rents	Positive
Hack (2002)	Toronto	Proximity to Metro	Commercial rents, residential rents and property	Positive

Table A.2 Summary of results from UK literature[a] (Sources: RICS Policy Unit 2002, p8, and GVA Grimley 2004, p66)

Source	Location	Impact of	Impact on	Impact
Chesterton (2000)	London Jubilee Line Extension (JLE)	Distance from stations	Residential property values	Positive
			Commercial occupancy levels	Positive
Chesterton (2002)	London Jubilee Line Extension (JLE)	Distance from stations	Residential values	Positive, but variable and not significant
			Commercial occupancy levels	Positive, but not significant
Pharoah (2002)	London Jubilee Line Extension (JLE)		Residential development applications	Positive, but in limited areas
			Commercial development applications	Sites close to stations sought for mixed use and commercial development
Wrigley and Wyatt (2001)	Review paper	Multi-sector	Residential and commercial property values	Intra-urban and regional
Hillier Parker (2002)	London Crossrail (projected)	Impact 1km from stations	Residential – new dwellings	54,804 new dwellings by 2025
			Commercial floor space added	10.87m sq metres additional floor space by 2025
Henneberry (1998)	Sheffield Supertram	LRT	Residential property values	House prices fell prior to construction, but losses disappeared after opening
Dabinett (1998)	Sheffield Supertram	LRT	Non-residential property values	Unable to detect any impacts
Dabinett (1998)	Sheffield and Manchester LRT	LRT	House prices	Influence too small to be distinguished
TRL (1993)	Tyne and Wear Metro	Metro	House prices	Increase in close proximity to stations
Du and Mulley (2007)	Tyne and Wear Metro	Metro	House prices	Increase in close proximity to stations, but not uniform
ATIS, RW and UCL (2004)	Croydon Tramlink	LRT	House prices	Accessibility is an important determinant of house prices

a) Add vales for impacts.

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Appendix B Case study employment data

Table B.1 Silverdale employment 1-digit-level summary

	Agriculture, forestry and fishing	Mining	Manufacturing	Electricity, gas, water and waste services	Construction	Wholesale trade	Retail trade	Accommodation and food services	Transport, postal and warehousing	Information media and telecommunications	Financial and insurance services	Rental, hiring and real estate services	Professional, scientific and technical services	Administrative and support services	Public administration and safety	Education and training	Health care and social assistance	Arts and recreation services	Other services	Total - all industries
Silverdale South																				
% Δ 2000–05	3900%	0%	30%	-52%	57%	69%	8%	71%	-29%	0%	200%	-28%	700%	567%	733%	-28%	50%	-67%	50%	50%
% Δ 2000–09	4567%	0%	19%	-100%	118%	62%	-20%	0%	14%	0%	0%	0%	633%	400%	900%	-28%	150%	67%	75%	63%
Change 2000–05	117.0	0.0	190.0	-13.0	350.0	90.0	20.0	25.0	-10.0	0.0	6.0	-7.0	105.0	17.0	22.0	-7.0	6.0	-6.0	20.0	925.0
Change 2000–09	137.0	0.0	120.0	-25.0	**720.0**	80.0	-50.0	0.0	5.0	0.0	0.0	0.0	95.0	12.0	27.0	-7.0	18.0	6.0	30.0	1168.0
Silverdale North																				
% Δ 2000–05	-50%	0%	-83%	0%	100%	0%	567%	0%	-14%	0%	0%	0%	300%	0%	0%	-75%	39%	0%	0%	101%
% Δ 2000–09	-50%	0%	-43%	0%	233%	0%	844%	0%	43%	0%	0%	0%	100%	0%	0%	-100%	11%	0%	0%	235%
Change 2000–05	-3.0	0.0	-29.0	0.0	9.0	0.0	102.0	0.0	-5.0	0.0	0.0	6.0	9.0	6.0	0.0	-9.0	7.0	35.0	9.0	137.0
Change 2000–09	-3.0	0.0	-15.0	0.0	21.0	3.0	152.0	25.0	15.0	0.0	0.0	9.0	3.0	0.0	0.0	-12.0	2.0	110.0	9.0	319.0
Rodney District																				
% Δ 2000–05	-50%	0%	16%	-32%	19%	26%	18%	44%	10%	-7%	60%	20%	74%	8%	29%	30%	23%	20%	67%	24%
% Δ 2000–09	-50%	-58%	8%	9%	29%	49%	16%	45%	7%	-38%	80%	5%	94%	11%	63%	41%	56%	38%	86%	30%
Change 2000–05	-3.0	0.0	390.0	-35.0	359.0	140.0	440.0	540.0	70.0	-30.0	120.0	80.0	400.0	30.0	120.0	410.0	330.0	80.0	340.0	3781.0
Change 2000–09	-3.0	-75.0	180.0	10.0	537.0	260.0	410.0	560.0	50.0	-170.0	160.0	20.0	510.0	40.0	260.0	560.0	800.0	150.0	440.0	4699.0
Auckland Region																				
% Δ 2000–05	4%	27%	4%	29%	36%	14%	14%	15%	1%	-5%	9%	27%	38%	21%	20%	28%	18%	26%	19%	16%
% Δ 2000–09	-9%	27%	-8%	28%	41%	12%	13%	23%	0%	-5%	20%	22%	64%	17%	48%	36%	41%	45%	27%	20%
Change 2000–05	230.0	90.0	3530.0	840.0	8720.0	6480.0	7540.0	4430.0	250.0	-1010.0	1960.0	2290.0	14580.0	5990.0	3760.0	10430.0	7250.0	1980.0	3050.0	82390.0
Change 2000–09	-570.0	90.0	-6510.0	800.0	10030.0	5650.0	7190.0	7050.0	-80.0	-990.0	4090.0	1860.0	24210.0	4890.0	9110.0	13750.0	16620.0	3460.0	4490.0	105140.0

Table B.2 Silverdale employment 1-digit-level detail

	Agriculture, forestry and fishing	Mining	Manufacturing	Electricity, gas, water and waste services	Construction	Wholesale trade	Retail trade	Accommodation and food services	Transport, postal and warehousing	Information media and telecommunications	Financial and insurance services	Rental, hiring and real estate services	Professional, scientific and technical services	Administrative and support services	Public administration and safety	Education and training	Health care and social assistance	Arts and recreation services	Other services	Total - all industries
Silverdale South																				
2000	3	-	630	25	610	130	250	35	35	0	3	25	15	3	3	25	12	9	40	1853
2001	9	-	650	25	570	120	220	40	30	3	3	25	60	15	3	18	15	6	60	1872
2002	18	-	650	25	550	130	230	30	30	0	3	30	50	20	9	15	12	6	40	1848
2003	12	-	720	30	720	150	250	30	35	0	6	25	60	30	9	18	15	12	45	2167
2004	18	-	790	9	730	170	210	75	25	6	15	25	85	35	15	15	18	9	45	2295
2005	120	-	820	12	960	220	270	60	25	0	9	18	120	20	25	18	18	3	60	2778
2006	110	0	840	25	1030	190	250	45	40	0	6	30	100	20	35	50	20	25	50	2866
2007	120	0	830	25	1180	170	190	40	40	0	3	30	130	15	40	20	35	18	60	2946
2008	130	-	810	35	1390	210	230	35	40	0	0	30	120	20	40	25	40	15	60	3230
2009	140	-	750	0	1330	210	200	35	40	0	3	25	110	15	30	18	30	15	70	3021
% Δ 2000–05	**3900%**	**0%**	**30%**	**-52%**	**57%**	**69%**	**8%**	**71%**	**-29%**	**0%**	**200%**	**-28%**	**700%**	**567%**	**733%**	**-28%**	**50%**	**-67%**	**50%**	**50%**
% Δ 2000–09	**4567%**	**0%**	**19%**	**-100%**	**118%**	**62%**	**-20%**	**0%**	**14%**	**0%**	**0%**	**0%**	**633%**	**400%**	**900%**	**-28%**	**150%**	**67%**	**75%**	**63%**
Change 2000–05	**117**	**0**	**190**	**-13**	**350**	**90**	**20**	**25**	**-10**	**0**	**6**	**-7**	**105**	**17**	**22**	**-7**	**6**	**-6**	**20**	**925**
Change 2000–09	**137**	**0**	**120**	**-25**	**720**	**80**	**-50**	**0**	**5**	**0**	**0**	**0**	**95**	**12**	**27**	**-7**	**18**	**6**	**30**	**1168**
Silverdale North																				
2000	6	0	35	0	9	0	18	0	35	0	0	0	3	0	0	12	18	0	0	136
2001	3	0	3	0	12	0	15	0	9	0	0	9	3	0	0	6	20	6	0	86
2002	9	0	6	0	9	0	15	0	6	0	0	3	0	3	0	3	25	9	0	88
2003	3	0	9	0	6	0	20	0	3	0	0	9	6	25	0	6	35	9	0	131
2004	6	0	9	0	15	0	80	0	35	0	0	6	6	3	0	3	35	25	12	235
2005	3	0	6	0	18	0	120	0	30	0	0	6	12	6	0	3	25	35	9	273
2006	3	0	3	0	18	12	130	0	35	0	0	0	12	6	0	6	20	110	9	364
2007	6	20	18	0	35	3	180	35	35	0	0	3	15	6	0	6	15	100	9	486
2008	3	9	30	0	35	3	200	35	35	0	0	15	3	0	0	0	15	150	9	542
2009	3	-	20	0	30	3	170	25	50	0	0	9	6	0	0	0	20	110	9	455
% Δ 2000–05	**-50%**	**0%**	**-83%**	**0%**	**100%**	**0%**	**567%**	**0%**	**-14%**	**0%**	**0%**	**0%**	**300%**	**0%**	**0%**	**-75%**	**39%**	**0%**	**0%**	**101%**
% Δ 2000–09	**-50%**	**0%**	**-43%**	**0%**	**233%**	**0%**	**844%**	**0%**	**43%**	**0%**	**0%**	**0%**	**100%**	**0%**	**0%**	**-100%**	**11%**	**0%**	**0%**	**235%**
Change 2000–05	**-3**	**0**	**-29**	**0**	**9**	**0**	**102**	**0**	**-5**	**0**	**0**	**6**	**9**	**6**	**0**	**-9**	**7**	**35**	**9**	**137**
Change 2000–09	**-3**	**0**	**-15**	**0**	**21**	**3**	**152**	**25**	**15**	**0**	**0**	**9**	**3**	**0**	**0**	**-12**	**2**	**110**	**9**	**319**
Rodney District																				
2000	6	130	2380	110	1856	530	2490	1240	670	450	200	400	540	370	410	1360	1440	400	510	15492
2001	3	130	2640	110	1786	520	2540	1270	640	410	210	340	590	300	390	1450	1430	390	580	15729

	Agriculture, forestry and fishing	Mining	Manufacturing	Electricity, gas, water and waste services	Construction	Wholesale trade	Retail trade	Accommodation and food services	Transport, postal and warehousing	Information media and telecommunications	Financial and insurance services	Rental, hiring and real estate services	Professional, scientific and technical services	Administrative and support services	Public administration and safety	Education and training	Health care and social assistance	Arts and recreation services	Other services	Total - all industries
2002	9	130	2610	110	1692	650	2500	1360	630	370	220	350	660	330	410	1540	1540	410	620	16141
2003	3	120	2920	140	1817	640	2550	1450	660	360	280	450	730	350	430	1680	1600	450	700	17330
2004	6	110	2960	75	2032	660	2780	1700	710	370	280	460	830	450	470	1770	1670	470	790	18593
2005	3	130	2770	75	2215	670	2930	1780	740	420	320	480	940	400	530	1770	1770	480	850	19273
2006	3	90	2670	110	2320	700	3040	1880	770	530	320	450	970	450	630	1810	1930	620	870	20163
2007	6	70	2700	100	2354	670	2970	1960	760	480	340	450	1060	540	670	1860	1980	560	930	20460
2008	3	90	2770	160	2434	760	3220	2010	750	270	370	470	1140	410	710	1990	2140	630	960	21287
2009	3	55	2560	120	2393	790	2900	1800	720	280	360	420	1050	410	670	1920	2240	550	950	20191
% Δ 2000–05	**-50%**	**0%**	**16%**	**-32%**	**19%**	**26%**	**18%**	**44%**	**10%**	**-7%**	**60%**	**20%**	**74%**	**8%**	**29%**	**30%**	**23%**	**20%**	**67%**	**24%**
% Δ 2000–05	**-50%**	**-58%**	**8%**	**9%**	**29%**	**49%**	**16%**	**45%**	**7%**	**-38%**	**80%**	**5%**	**94%**	**11%**	**63%**	**41%**	**56%**	**38%**	**86%**	**30%**
Change 2000–05	**-3**	**0**	**390**	**-35**	**359**	**140**	**440**	**540**	**70**	**-30**	**120**	**80**	**400**	**30**	**120**	**410**	**330**	**80**	**340**	**3781**
Change 2000–09	**-3**	**-75**	**180**	**10**	**537**	**260**	**410**	**560**	**50**	**-170**	**160**	**20**	**510**	**40**	**260**	**560**	**800**	**150**	**440**	**4699**
Auckland Region																				
2000	6,310	330	82,960	2,850	24,400	47,120	54,630	30,360	31,960	19,990	20,750	8,380	38,060	29,160	19,080	37,780	40,770	7,620	16,420	518930
2001	6,200	320	81,720	3,000	23,920	48,820	55,270	29,350	30,020	18,270	20,280	8,190	41,900	28,760	19,750	38,280	42,810	7,520	16,590	520970
2002	6,490	370	82,020	3,120	23,620	49,420	56,440	30,780	29,360	18,410	20,080	8,200	42,280	28,280	21,160	42,330	44,320	9,050	17,230	532960
2003	6,930	370	84,500	3,200	26,040	50,460	57,690	32,490	30,080	17,650	21,390	8,950	45,120	30,150	21,750	45,980	45,270	9,300	18,370	555690
2004	6,710	360	85,570	3,260	29,000	52,130	60,560	33,900	30,880	17,970	22,160	9,810	48,060	34,430	22,850	47,560	46,630	9,350	19,080	580270
2005	6,540	420	86,490	3,690	33,120	53,600	62,170	34,790	32,210	18,980	22,710	10,670	52,640	35,150	22,840	48,210	48,020	9,600	19,470	601320
2006	6,040	420	84,260	3,780	34,530	54,040	63,280	37,320	33,260	18,740	24,810	10,540	57,730	35,440	23,260	47,650	50,070	10,360	20,280	615810
2007	6,180	380	82,490	4,040	36,480	53,650	65,330	38,300	32,220	18,960	25,520	10,890	58,070	37,300	24,570	50,780	52,350	10,550	20,900	628960
2008	5,850	490	81,450	4,270	37,480	55,020	66,500	39,230	34,410	19,420	25,380	10,800	62,440	38,330	25,920	51,810	53,920	10,790	21,640	645150
2009	5,740	420	76,450	3,650	34,430	52,770	61,820	37,410	31,880	19,000	24,840	10,240	62,270	34,050	28,190	51,530	57,390	11,080	20,910	624070
% Δ 2000–05	**4%**	**27%**	**4%**	**29%**	**36%**	**14%**	**14%**	**15%**	**1%**	**-5%**	**9%**	**27%**	**38%**	**21%**	**20%**	**28%**	**18%**	**26%**	**19%**	**16%**
% Δ 2000–09	**-9%**	**27%**	**-8%**	**28%**	**41%**	**12%**	**13%**	**23%**	**0%**	**-5%**	**20%**	**22%**	**64%**	**17%**	**48%**	**36%**	**41%**	**45%**	**27%**	**20%**
Change 2000–05	**230**	**90**	**3530**	**840**	**8720**	**6480**	**7540**	**4430**	**250**	**-1010**	**1960**	**2290**	**14580**	**5990**	**3760**	**10430**	**7250**	**1980**	**3050**	**82390**
Change 2000–09	**-570**	**90**	**-6510**	**800**	**10030**	**5650**	**7190**	**7050**	**-80**	**-990**	**4090**	**1860**	**24210**	**4890**	**9110**	**13750**	**16620**	**3460**	**4490**	**105140**

Appendix C Rodney District Council zoning maps

Figure C.1 RDC 2000 District Plan Map 76

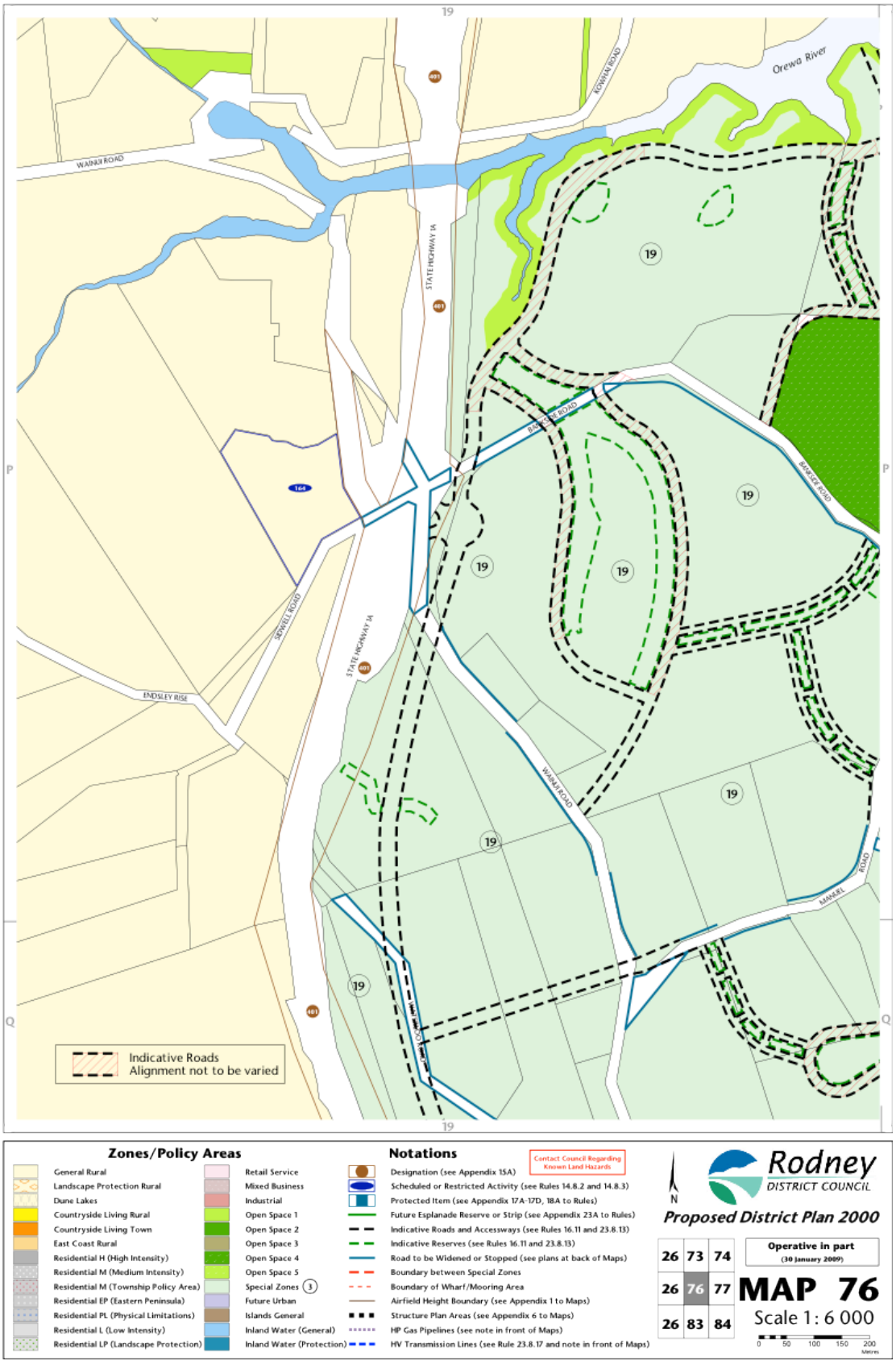

Figure C.2 RDC 2000 District Plan Map 77

Figure C.3 RDC 2000 District Plan Map 83

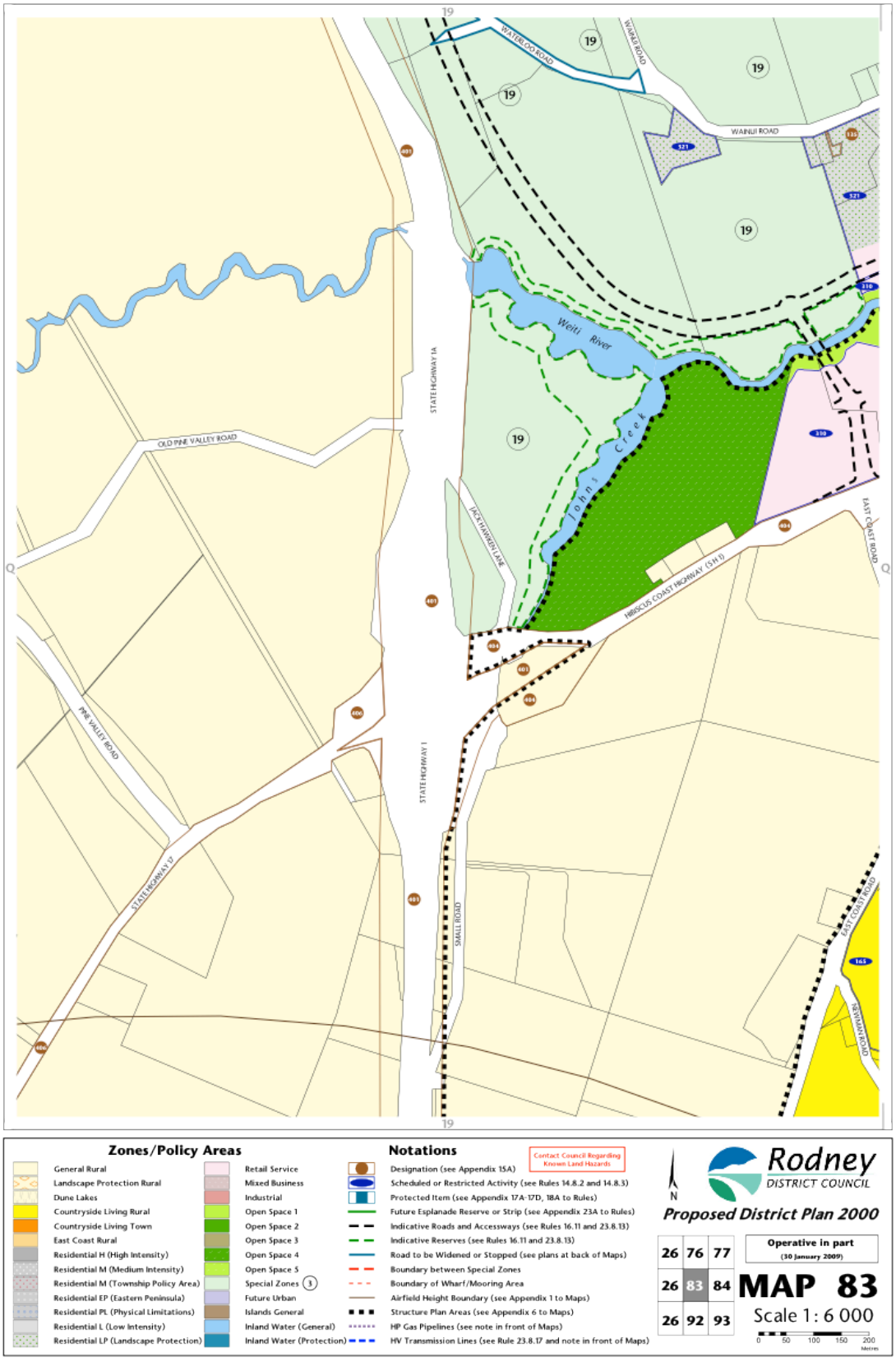

Figure C.4 RDC 2000 District Plan Map 84