Ministry of Transport
TE MANATŪ WAKA

AUCKLAND ROAD PRICING STUDY 2008

EXECUTIVE SUMMARY REPORT

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EXECUTIVE SUMMARY REPORT

Contents

List of Figures

List of Tables

Part 1: Overview and Approach

1 Introduction

1.1 Purpose

This Executive Summary Report (Report) summarises a series of analyses undertaken on the positive and negative impacts of the introduction of two hypothetical road-pricing schemes in Auckland. The analyses were undertaken to supplement and enhance the evaluation carried out for the Auckland Road Pricing Evaluation Study (ARPES 2006) in 2005/06. The purpose of this Report is to allow Ministers to reach a view as to whether charging on existing urban roads is a tool worth adding to the transport toolkit.

1.2 Background

In March 2004 the New Zealand Cabinet requested the Ministry of Transport (the Ministry) to investigate the feasibility and desirability of road pricing in Auckland.

The results of that investigation, known as the Auckland Road Pricing Evaluation Study (ARPES 2006), were publicly released at the Auckland Mayoral Forum on 17 March 2006. Following this public release, a six-week consultation and submissions process was launched and, on 15 February 2007, the government announced that it was undertaking further work following on from the submissions process. This report represents the culmination of this further work to better understand the issues raised by submitters. In particular, the Report builds understanding of the possible economic, social and environmental benefits and costs of road pricing.

1.3 Objectives of the study

Two conceptual schemes have been used as a basis for analysis: one focuses on reducing congestion and the other focuses on raising revenue. Both schemes are similar in design to one of the original schemes considered in ARPES 2006.

The objective of the analysis is not to design a preferred scheme. The Ministry's main aim in undertaking this further programme of work is to provide, in specific areas, greater depth of analysis than that undertaken in ARPES 2006, for the purpose of ensuring that the issues raised in submissions are considered in detail.

The findings of ARPES 2006 (summarised in Annex 1) were that, to greater or lesser extents, the different schemes provided a range of benefits, including benefits to road users (improved trip times, greater reliability), environmental and mode shift (to public transport, walking and cycling) benefits, along with revenues to support the development of better transport systems. There were, however, questions about:

- whether public transport could be a real and viable alternative in a low-density environment. The most consistent feedback the Ministry received from submissions was that congestion charging was impractical unless there were adequate alternatives to using a car
- uncertain impacts on commercial and retail areas, particularly in central Auckland
- affordability and social inequity and, particularly, impacts on low-income households.

Some analysis tasks were specifically excluded from the programme of work:

- Advice on whether any scheme should be administered by central or local government or both in partnership.
- Advice on any other ownership or governance issues, including ownership of revenues.
- Detailed recommendations as to a preferred scheme. The goal is not to arrive at an optimal scheme. Such optimisation must wait until government has made decisions on whether to implement road pricing.

1.4 Process

To provide the additional analysis required, a work programme was structured to include traffic modelling, public transport analysis, economic analysis (including case studies), financial modelling, assessment of social, environmental and land use impacts, technology and cost issues, and assessment of travel choice and equity options other than passenger transport.

The individual workstreams were conducted by experts in their fields, coordinated by the Ministry of Transport.

The Ministry of Transport, supported by information provided by the Auckland Regional Council (ARC) and Hill Young Cooper, also undertook an analysis of the extent to which the two schemes considered would contribute to the objectives of the New Zealand Transport Strategy (NZTS).

From early in the study, a group of officials from ARC, Auckland Regional Transport Authority (ARTA), Auckland City Council, Transit New Zealand (Transit), and Land Transport New Zealand (Land Transport NZ) (now NZ Transport Agency) have assisted in refining aspects of the two schemes, and guiding the work programme.

It is important to note that the modelling carried out for this study (the same as for ARPES 2006) has been purpose-designed for a comparative analysis of schemes. Care should be taken in examining the results for each scheme in terms of their actual absolute impact on congestion. The model output sensitivity was analysed in the previous ARPES work. The outputs of the transportation, financial and spatial impact models are only as good as the inputs and the predictive ability of the models.

1.5 Report structure

This report is broken down into four main parts:

- **Part 1** provides an overview and contextual introduction for the study.
- **Part 2** focuses on the Congestion Scheme. It describes the scheme in detail, and summarises the findings of the individual workstreams on the performance of the scheme in relation to the issues that they have addressed.
- **Part 3** focuses on the Revenue Scheme. It describes the scheme in detail, and summarises the findings of the individual workstreams on the performance of the scheme in relation to the issues that they have addressed.
- **Part 4** combines the conclusions from the investigations and responds in a structured way to the issues raised in submissions to ARPES 2006.

Individual workstream reports are available separately from the Ministry of Transport's website.

2 Submissions on ARPES 2006

2.1 Introduction

Following publication of ARPES 2006 in March 2006, and public release at the Auckland Mayoral Forum on 17 March 2006, a six-week consultation and submissions process was launched, with submissions closing on 28 April 2006. A report describing the submissions received is available at: http://www.transport.govt.nz/assets/NewPDFs/Auckland-Road-Pricing/Submissions-Analysis-Report.pdf.

The request for submissions on the discussion document resulted in over 800 replies from individuals and organisations. Approximately 75% of submissions were identified as being against or conditionally against road pricing either in principle or as a means of addressing Auckland traffic congestion. Approximately 78% of submissions were received from individuals, with the remainder coming from organisations and pro forma submissions. Submitters opposing road pricing pointed to the inadequate state of Auckland's public transport network, the lack of a 'ring road' to allow travel from south to north (and vice versa) without entering heavily congested areas, an aversion to the concept of road pricing on roads that have been fully funded (financially) through existing taxes, and the perceived unfair application of a flat pricing structure across all groups in society

The degree of overall opposition to road pricing referred to above was heavily influenced by the collective views of individuals. By comparison, those from larger organisations displayed a higher level of conditional support for road pricing through recognition that Auckland's congestion issues must be addressed for the benefit of the country. Their support tended to be conditional upon investment in land transport (roads and/or public transport) prior to the implementation of road pricing. Larger organisations, including local authorities, also focused more on the wider economic benefits and costs of road pricing. Most major submissions welcomed the Ministry's efforts in preparing the ARPES 2006 report and its initiative in attempting to address traffic congestion.

Local authorities were generally supportive of exploring road pricing as an option (among a possible portfolio of other options) to address congestion. The level of specific support from individual councils varied according to how that council's constituents were likely to be impacted by the proposed schemes.

2.2 Detailed reasons

There were a number of main reasons given by those opposed to road pricing:

- Roads were viewed as a free public good and there was opposition to the idea of charging for that good. Implicit in this view was the notion that submitters saw road pricing as charging for the use of roads rather than as a means to price congestion on those roads and thereby influence an individual's decision to use private transport in peak congestion times.
- Further, many submitters expressed the view that existing roads (particularly assets that were subject to a tolling regime at some stage, such as the Harbour Bridge) had already been fully paid for through existing central government taxes, local rates, fuel excises and road user charges. As such, the view tended to be that the roads are owned by the people and they resent the notion of additional charges for their use.
- The standard of Auckland's public transport system was highlighted in the majority of submissions as one of the key contributors to Auckland congestion. People indicated a reluctance to use public transport because it was viewed as:

  - inconvenient – commuters cannot get where they want to go within a reasonable time frame
  - expensive – many submitters pointed out that even with recent increases in fuel prices, public transport is a more expensive option than private vehicle transport (frequently the reason given was multiple fares being required for a single journey)
  - unreliable – trains and buses do not run to advertised schedules
  - unsafe – long walks in unlit areas to bus stops and train stops were viewed as a significant deterrent to using public transport.
- A lack of cycleways and walkways in and out of the city was also raised, particularly in relation to the Harbour Bridge.
- A view was expressed that there is no 'ring road' or alternative route from south to north, other than through heavily congested areas, and this was viewed as a key contributor to congestion.
- A flat pricing structure for roads was viewed as being inequitable insofar as it is likely to have a greater relative impact on lower socio-economic groups because the charge will represent a greater proportion of the disposable income of those groups.
- A large group of submitters expressed concerns about the ability of road pricing to reduce congestion, on the basis that many commuters have no viable alternative to private vehicle transportation.

Where support for pricing was indicated, it was often accompanied by conditions:

- Investment in land transport (roads and/or public transport) is required prior to road pricing so that commuters have a viable alternative.
- Exemptions should be given for particular groups, intended either to address equity concerns or serve the interests of particular submitting groups.
- Revenue raised through road pricing should be directed towards land transport projects – roads and/or public transport.
- The ARPES 2006 report should be developed further to include a full consideration of possible social and economic impacts.

Individual submitters often referred to the private cost and associated affordability of the proposed road-pricing schemes. By comparison, submissions from organisations tended to focus more on the wider economic implications of road pricing.

The work programme for this Report has been built heavily around responding to the issues that submitters raised. This Report, and the individual reports prepared during the study, have all focused on providing the greater depth of analysis required to respond to these issues.

3 Why Consider Road Pricing?

3.1 Introduction

There is little doubt that congestion is a problem in New Zealand's major urban centres, particularly in Auckland. It affects quality of life and imposes a burden on businesses and residents alike through delays, unreliable journey times and the opportunity cost of time spent sitting in traffic. Both residents and businesses record high levels of dissatisfaction with the degree of congestion experienced.

The problem is compounded by a deficit in infrastructure investment during the period 1970 - 2000, and passenger transport services with poor levels of connectivity, regularity, reliability and speed in comparison to Australian metropolitan areas. The Government is now seeking to address this deficit but there remains a significant funding gap between what is affordable and what is desirable. A road-pricing scheme could help fund this gap.

Transport modelling outputs (Table 1) suggest that, despite some mode shifts, in the AM peak the number of vehicles accessing destinations in the inner isthmus will grow by 9%, with a region-wide increase in traffic of over 30% between 2001 and 2021. This escalation of traffic volumes is a result of both population and employment growth in Auckland, and is set to place significant pressure on the road network.

Table 1: Projected trip patterns into the inner isthmus – AM peak period

Type of trip	2001	2021	Change (%)
Vehicle	77,545	84,805	9.4%
Car passenger	19,504	19,776	1.4%
Walking and cycling	16,459	26,685	62.1%
Public transport (PT)	15,793	23,861	51.1%

3.2 Challenges of growth

3.2.1 Population and land use

The Auckland region has experienced a period of rapid growth over the past 10 years. Between 1996 and 2006 the region's population grew at an annual average rate of 2%, adding over 230,000 people to its resident base. Meanwhile, employment has grown at about 4.6% per annum over the five years between 2001 and 2006; with 120,000 jobs added to the regional workforce. This has been putting pressure on labour markets, the property market, employment and occupancy costs. Forecasts indicate a continuation of fast growth rates. The most recent projections from Statistics New Zealand (2006 base year, medium projection series) suggest a regional population in the order of 1.82m by 2026; up from 1.37m in 2006.

In light of these projections Auckland local authorities developed an Auckland Regional Growth Strategy (RGS) as a vision for what Auckland could be like in 50 years time with a population of two million. This initiative has identified several growth nodes concentrated in the middle-to-outer region (including the Auckland CBD), which are expected to accommodate a substantial proportion of future growth.

To date, growth has tended to focus on the outer ring of the metropolitan area and along major arterials, reflecting the fundamental drivers of current business location decision, which are heavily influenced by transport access and proximity to workforce. Modelling of future land use patterns suggests that, while current policies are likely to help somewhat with the 'hubbing' of land uses in the RGS centres, the basic driver of peripheral expansion remains. The 2007 evaluation of the Regional Growth Strategy notes that, while progress has been made, the region needs to take a more sophisticated approach to implementing the RGS by using new tools and approaches to achieve better, quicker implementation and on a larger scale. Road pricing may provide part of the answer.

3.2.2 Levels of congestion

During ARPES 2006, surveys carried out among Auckland businesses and residents showed that most Aucklanders consider traffic congestion across the region to be a serious problem. Ninety-four percent of residents surveyed identified the reduction of traffic congestion as "important" or "very important". Businesses felt even more strongly about traffic congestion. Over 80% of all businesses surveyed thought it "very important" to reduce traffic congestion, with virtually all of the remainder feeling it was "important". The strong message received from the surveys undertaken for ARPES 2006 was that "something needs to be done".

A key component of the 2007/08 update has been engagement with road carriers, retailers and other businesses in order to assess the potential economic impact of a road-pricing scheme in Auckland (refer Sections 7 and 16). The results of this consultation show that the adverse impacts of congestion are felt most strongly by road carriers. Traffic congestion is significantly reducing their productivity and profitability. Road carriers are increasing their fleet size, extending their hours of operation and bearing increased employment and vehicle-related costs (eg fuel) because of congestion. Congestion also affects the ability of businesses to reach their clients. Because congestion increases the cost of travel, it also affects the willingness of people to travel to, or through, congested areas to get to their places of work.

Transport modelling outputs provided by the ARC show expected network capacity and traffic volumes in 2016 in a non-pricing environment for the entire Auckland region. A number of transport projects have been added to the 2001 network to reflect the anticipated 2016 network. These include additions to SH1, SH18, SH16, SH20 and 20A plus several other projects. The network performance changes between 2001 and 2016 ('no-pricing') are summarised in Table 2.

Table 2: AM peak period network performance summary

Measure	2001 AM	2016 AM ('no-pricing')
Population (urban area)	1,054,287	1,363,187
Vehicle trips	358,265	446,157
PT share/patronage	10.5% / 62,908	11.2% / 84,213
Walk and cycle share	14.4%	15.6%
Average network speed	38.8 kph	39.6 kph

Travel demand is expected to increase by 25% between 2001 and 2016. The average speed across the entire Auckland network is expected to increase marginally, due mainly to a considerable number of additional roading projects assumed to be in place by 2016, including the Victoria Park Tunnel, Mt Roskill Extension and the Waterview Connection. In summary, this considerable investment (amounting to approximately $4 billion in total) will allow authorities to just keep up with current traffic conditions; there is no scope for a reduction in congestion.

Further, despite considerable investment planned for public transport there will be only a slight increase in PT mode share.

Overall, measures of network predictability show little change between 2001 and 2016 under the no-pricing scenario. Free-flow speed will reduce from 0.80 to 0.79 and the percentage of travel on congested networks will remain at 20%. This indicates that even with the planned heavy investment in roading projects and passenger transport services the level of network congestion is expected only to remain constant rather than improve over time. Travel times between key employment or economic centres are expected to increase from 15 minutes in 2001 to 22 minutes in 2016 under a no-pricing scenario.

The number of vehicle kilometres travelled (VKT) on the network with level of service E or F (stop-start conditions) is expected to increase to 809,590 VKT without pricing. Accessibility is not expected to improve under a no-pricing scenario. The proportion of households within 30 minutes of an employment centre by car or passenger transport is expected to remain approximately constant, at about 61%, between 2001 and 2016.

3.2.3 Environment

The environmental assessment undertaken by Hill Young Cooper has highlighted the longer-term pressures on the Auckland region's environment (such as air and water pollution). So while significant expenditure on the roading network and PT may enable the region to come relatively close to keeping pace with congestion, it is tracking poorly with respect to environmental performance.

The New Zealand Government has recently set some ambitious energy, climate change, sustainability and economic transformation goals. The New Zealand Energy Efficiency and Conservation Strategy (NZEECS), together with its companion document – the New Zealand Energy Strategy (NZES) – sets out a detailed action plan to address these sustainability objectives and to guide the development of the proposed targets in the updated NZTS.

The transport sector consumes more energy than any other sector (44% of annual energy usage). It is also the fastest growing sector in terms of energy use, and unless action is taken, emissions from this sector are set to grow by 35% by 2030. About 18% of New Zealand's greenhouse gas emissions are carbon dioxide emissions from the transport sector, and road transport represents about 89% of these emissions. In order to make sure the transport sector is producing energy efficiency and conservation gains the government has set some targets which will be used to assess progress. Such targets include halving per capita greenhouse gas transport emissions by 2040 relative to 2007 levels, and substantially reducing the number of premature deaths and serious illnesses arising from air pollution from motor vehicles.

In fact, under the no-pricing scenario, carbon emissions are currently predicted to continue to *increase* by nearly 50% over 1991 levels by 2016. Overall, modelling results indicate that under a no-pricing scenario Auckland is unlikely to achieve, or contribute to in any significant form, the targets set out in the updated NZTS. Indeed, the data modelled indicates an average increase in peak period (7-9am) vehicular carbon emissions of approximately 18,000 kg every year.

Amenity, severance and noise impacts assessment

Amenity effects (such as traffic noise) and severance effects are generally related to traffic volumes and speeds. There is a concern that growing traffic volumes and the resulting amenity effects are affecting the desirability of Auckland City in general and, in particular, around identified growth centres. Concerns about noise (and emissions) are the most commonly raised by the public in response to transport initiatives. As traffic volumes increase, noise issues may

arise in key locations and additional pressure is put on road design and layout, resulting in further impacts on amenity and accessibility. For example, more and more traffic lanes would be required, resulting in less and less space for footpaths, trees and parking, and consequently impacting on walking, cycling and other activities along the road corridors.

Significant increases in traffic volumes along local and arterial roads within the north and south Auckland sectors are anticipated during the period to 2016[1]. As a direct result of these increases in traffic volumes, the communities around these links could expect a reduction in the general amenity and accessibility, and potentially noticeable increases in traffic noise.

Stormwater quality impacts assessment

Road transport activities have an adverse effect on the quality of stormwater running off urban roads and draining to urban streams and coastal waters. Motor vehicle usage results in the discharge of contaminants such as hydrocarbons, copper and zinc onto the road surface. Several of these contaminants are major biohazards, and can accumulate to the point where they occur at levels that may have adverse effects on ecological values.

Modelling at an overall regional level indicates that future increases in VKT from 2001 volumes, with no intervention would be around 16.5% in 2016 and 21.6% in 2021. The predicted increases in VKT vary between areas, with eight of the nine roading catchments draining to sensitive estuarine environments seeing increases in VKT at 2021 ranging from 12% in Hobson and Whau-Waterview to 71% in Pukaki. These increases in VKT are forecast to result in increasing adverse effects on sensitive receiving environments, particularly the outer catchments in the northern and southern sectors.

Air quality impacts assessment

Many vehicular emissions potentially result in respiratory or cardiovascular problems and other health effects which, in turn, have considerable implications on hospital resources, lost work and school days and restricted personal activity. A recent report by Auckland Regional Public Health (ARPH, 2007) found a positive correlation between particulate (PM10) emissions and mortality and health impacts, as well as concomitant effects from other pollutants, and estimated that over 400 deaths in Auckland a year could be attributed to PM10 emissions, with the majority related to vehicle emissions.

Modelling projections are that, although volumes and VKT will increase in the future, vehicular emissions of NOx, PM10 and VOC will decrease from 2001 levels as more effective fuel and emission standards are established. Notwithstanding this, motor vehicles form the single largest individual source of total annual emissions of these pollutants (70% of total emissions are from vehicle exhaust, 41% PM10, 71% NOx). Furthermore, most vehicular PM10 emissions are attributable to diesel exhaust (30% of regional total). Road pricing has the potential to reduce region-wide as well as localised air pollution problems by changing patterns of transport use within the region, particularly if schemes are designed with these objectives in mind.

[1] The situation is better in the west and on the isthmus, due largely to the expected effects of major motorway projects (SH18 Hobsonville and SH20 Avondale) which will absorb traffic increases on local and arterial roads (particularly Hobsonville Rd in Waitakere, St Lukes Rd and Richardson Rd), together with significant improvements to public transport and traffic demand management to the CBD area.

3.3 Road pricing and strategic transport projects

The government's overarching aspiration of achieving environmental sustainability has meant a shift in focus for transport investment and consequently there has been a 1092% increase in funding from the National Land Transport Fund (NLTF) for passenger transport projects for the period 1999-2007. However, as the analysis in the next section shows, investment in buses and rail alone will not achieve the results expected by the government, and road pricing could provide an important tool complementary to these initiatives.

There are several major infrastructure projects on the horizon for Auckland City; for example, a third harbour crossing, the Waterview Connection and a proposed CBD rail loop. These projects are critical to achieving an effective transport network in Auckland and this would not change if a road-pricing scheme were to be introduced. What a road-pricing scheme could do is assist in sustaining the benefits gained by investment in these projects by providing incentives for users of the transport network to change their behaviour. Road pricing tends to encourage greater use of walking, cycling and passenger transport, and discourages low-value trips. It also raises revenue which can be used to fund, at least in part, some of these major investments.

Empirical evidence from overseas demonstrates clearly that road pricing has the potential to deliver significant benefits in the areas that our current cost-recovery system fails to generate[2]; ie reducing congestion, environmental and health impacts. However, to be effective a road-pricing scheme cannot operate in isolation – complementary investment in transport infrastructure and services is vital, and the scheme must also be carefully designed to optimise desired land use and behaviour changes, such as greater utilisation of public transport, car pooling, and re-timing of low-value trips.

3.4 International perspectives

Internationally, there is an increasing move towards more direct charging for road use, particularly for heavy vehicles. A number of OECD countries are either implementing or investigating greater use of different revenue sources as they try to achieve dual objectives:

- Supplementing traditional funding sources to fund critical transport infrastructure
- Ensuring that transport policy and revenue-raising mechanisms reflect broader social, economic and (particularly) environmental objectives.

For larger urban centres in particular in these countries, congestion is seen to be constraining regional economic growth[3] – and yet it is now very difficult to get public support and planning approval to build more roads, so a strong focus on managing demand (including charging) is developing.

Charging schemes are becoming increasingly common and are used to raise revenue (eg, the toll rings in Norway), manage congestion (such as the schemes in Stockholm and London) or provide incentives to drive on certain roads to optimise the overall network speed (Singapore).

The most notable developments in the last year have been in Stockholm and the USA. Stockholm comfortably won a referendum on their congestion charge. The scheme also survived a change of government both at local and national level. In addition, five pilot schemes

[2] For more information please see the Auckland Road Pricing: Desktop Research on Economic Impacts

[3] For further information please see Department for Transport – UK, (2007). *Towards a Sustainable Transport System: Supporting Economic Growth in a Low Carbon World*. London.

are in the process of being implemented in the United States and US federal policy is now focused on those who are actively taking steps to reduce urban congestion[4].

International literature shows that road pricing can be one of the best ways to achieve multiple transport and urban development objectives (eg reduce congestion and emissions and raise revenue). However, it works best when used as part of a broader transport strategy; ie partnered with additional public transport investment and/or increased road capacity.

There is also a consensus that, taken overall, the schemes have had a barely perceptible impact on overall economic growth. In the cases of London, Stockholm and Singapore, the effects were small and background economic growth appears to have 'washed out' any adverse effects on their overall urban economies. These findings are consistent with the ARPES 2006 conclusions that, although there were likely to be some net losses in terms of business activity in the short-term, the overall effects are expected to be very small in relation to the wider magnitude of business costs and the economy as a whole.

Table 3 gives an example of the distribution of winners and losers for the London Scheme. The literature highlights that congestion charging in any city creates complex patterns of winners and losers – between sectors, industries and firms, and between geographical locations. A similarly complex picture would therefore be likely in a New Zealand city.

Table 3: London Congestion Charge 'winners and losers'

Winners	Losers
All passenger transport riders	Motorists with marginal trip values
Taxi riders and drivers	City centre businesses that depend on low-cost weekday car access
Motorists with high-value trips	Residents and motorists in border areas who receive spill-over impacts
Most city centre businesses	City centre parking revenue recipients
Overall city productivity	
Pedestrians and cyclists	

Source:Litman (2007) / NZIER

The literature also suggests that – when all these distribution effects are taken into account – the net generative effects are relatively small but positive. These positive net generative effects appear to apply more widely in situations where there is sustained growth in the regional economy, and where hypothecation (dedication) of revenues is focused on improvements in PT.

London, Stockholm and Singapore all experienced considerable economic growth during the introduction and implementation of congestion charging and this has clearly made it easier for local businesses and the public to accept. However, in both London and Stockholm, individuals and businesses have criticised the inconvenience and compliance costs associated with the congestion charges. Furthermore, there have also been some considerable boundary issues. In London these relate to the advantages and disadvantages of extending the scheme as businesses on the boundary have noted a decline in business. In Stockholm there is concern

[4] A proposed New York congestion scheme which would see motorists who enter the Manhattan area between 6am and 6pm on weekdays pay a US $8 charge for cars and US $21 charge for trucks in an effort to cut traffic and pollution, was stopped by a state assembly in April 2008. This would have been the first scheme in a large US city.

from commuters in the outer suburbs that inner-city residents are benefiting disproportionally to the burden of cost that they share.

3.5 Conclusions

Analysis of submissions following the 2006 ARPES study revealed that a number of respondents objected to the notion of congestion pricing as a solution to the sub-optimal traffic conditions. In reality road pricing aims to put a monetary value on congestion and users are paying for the ability to move more freely on a previously congested network. Essentially, our average charge system creates problems of congestion in higher-demand areas as charges are not well related to the sections of the network that cost more to develop and operate.

The introduction of a congestion charge could be an important component within a suite of initiatives aimed at remedying these issues. It could potentially provide environmental and time benefits and a push towards real solutions – mode change, fewer trips, car pooling and land use change. Furthermore, if the revenues generated are used to fund new infrastructure, better public transport services and smarter systems to manage congestion then road users would see significant benefits from a road-pricing scheme.

It should be noted that the international schemes discussed in this section were implemented against a background of low car dependency and a high PT mode share. This is not the case in Auckland and so parts two and three of this report will provide details of the analysis undertaken in an Auckland context and will determine whether similar conclusions of congestion reduction, economic effects, improved accessibility, lessening adverse environmental and health effects, and enhancement of quality of life can be drawn for an Auckland-based scheme.

Part 2: Congestion Scheme

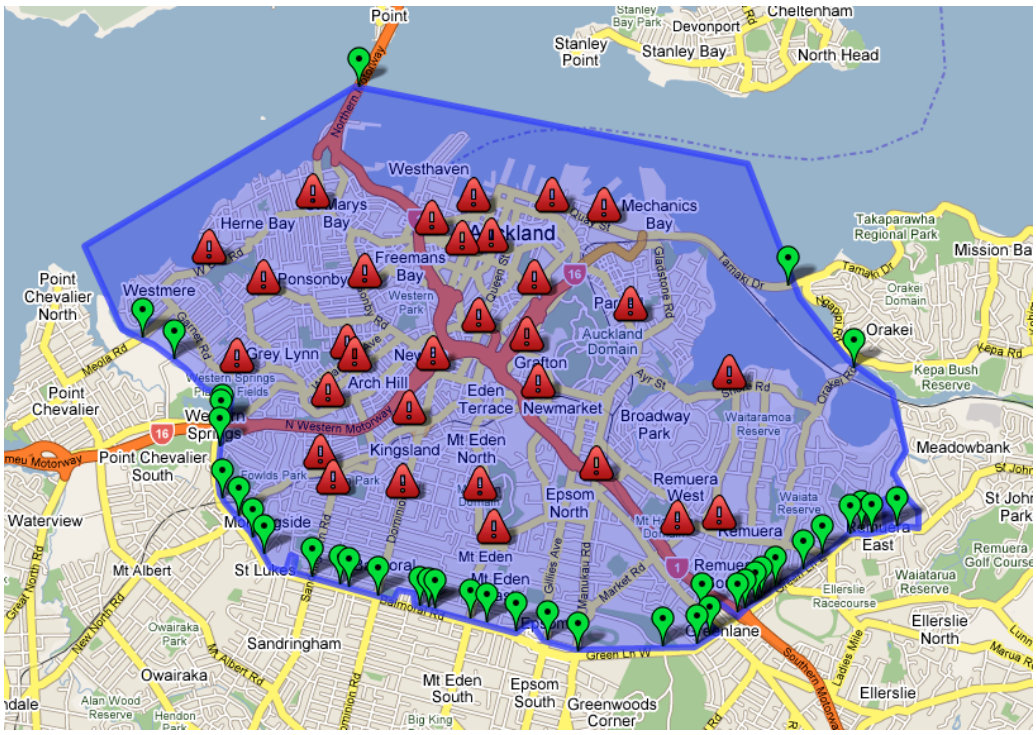
4 Objective of the Scheme

The Ministry's aim was to assess two different schemes that represented two very different approaches to pricing in Auckland; one with a clear focus on reducing peak-hour congestion and one focused on collecting revenue, but without any significant social or economic impacts. Therefore, the primary objective of the Congestion Scheme is to reduce congestion in Auckland during the morning peak period, with a particular focus on the Auckland Central area.

The pricing philosophy adopted for the scheme is to charge all vehicles entering, and those moving within, the charged area during the morning peak period. The charge level modelled is $6 per trip with a maximum $6 charge per day (ie one payment covers multiple entries and exits). This pricing approach should deter vehicles from travelling during the charged period as the cost of travel is materially higher, and aims to have the broad effects of reducing peak car travel demand, re-timing trips to non-charged time periods, increasing ride sharing, increasing trips made by public transport and active modes, and influencing travel behaviour by redistributing trips (ie changing routes or destinations).

The Congestion Scheme, as designed for this Report, is what is commonly referred to as an area scheme. This involves a charge when crossing the 'charging area' boundary as well as a charge for movement within the charging area. The boundaries for the Congestion Scheme are based on the area scheme zone boundaries from ARPES 2006 (see Figure 1 below – note that the green markers represent boundary charging points, and the red markers represent where internal charge points would be required to charge travel within the boundaries). The Congestion Scheme, as modelled, operates from 6am to 10am, five days per week. It includes all vehicles (motorbikes, taxies and trucks pay the charge) while buses receive a 100% discount.

Figure 1: Congestion Scheme



The findings from each of the workstreams in relation to the Congestion Scheme are set out in the following chapters.

5 Transportation Results

5.1 Introduction

The objectives of the transport-demand modelling undertaken by the ARC were to model the two scheme concepts to show the transport (road traffic and public transport) impacts of the schemes compared with the non-pricing environment. The results reinforce the findings of the ARPES study.

5.2 Traffic modelling

The regional travel demands were assessed using the future 2016 AM peak period (7-9am) demand estimates, the same process as for ARPES. The results for the Congestion Scheme are shown below in Table 4.

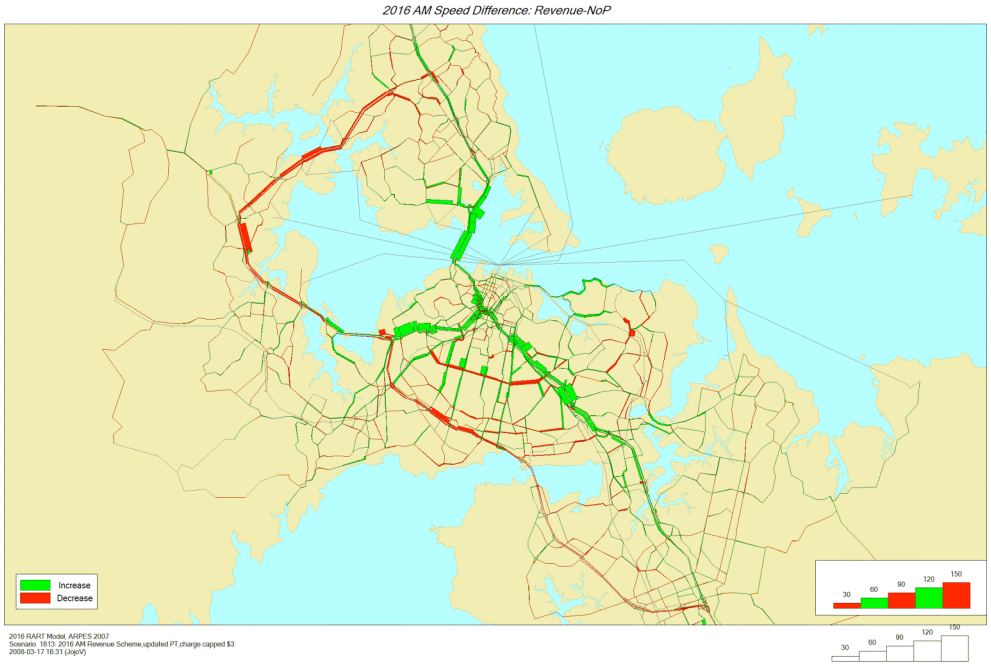
Table 4: Transportation modelling results: Congestion Scheme

Item	Unit	2001	Base 2016	Congestion 2016
Traffic demand	vehicle trips	358,265	446,157	403,667
Total vehicle kms travelled	kms	3,679,294	4,538,148	4,091,345
PT mode share	% of total trips	10.5%	11.2	15.0
Mode share of walk and cycle	% of total trips	14.4%	15.6	18.0
Average trip length	km	10.3	10.2	10.1
Average network speed (all network)	km/hr	38.8	39.6	43.3
Average network speed (isthmus)	km/hr	36.01	38.7	40.4
Average network speed (north)	km/hr	36.5	37.6	47.3
Average network speed (west)	km/hr	37.7	37.6	44.1
Average network speed (south)	km/hr	50.27	46.6	48.1
Average vehicle travel time	mins	15.9	15.4	14.1
Average PT pass travel time	mins	68.2	60.7	57.1
Car travel time to employment centres	mins	25	18.0	15.9
PT travel time to employment centres	mins	47	49.6	42.5
%age of VKT at LOS A/B	%	56.6	57.6	61.8
%age of VKT at LOS C/D	%	23.5	22.4	24.9
%age of VKT at LOS E/F	%	19.9	20.0	13.2

The reduction in trips in the Congestion Scheme is significant, partly because of a re-timing effect due to the limited charging period between 6am and 10am so that some trips re-time to travel outside this period.

Figure 2 below shows the strong network speed improvements through the central isthmus. It also demonstrates the need to consider management of diversion from the scheme charging zones (eg to use the Western Ring Route) in any detailed scheme design process.

Figure 2: Network speed changes - Congestion Scheme vs 'no-pricing'



In summary, the traffic results for the Congestion Scheme show that:

- Significantly fewer trips are generated across the network (about 10%), and total vehicle kilometres travelled during the peak period also reduce significantly (by about 10%).
- Public transport and walking and cycling mode shares increase significantly, demonstrating the extent to which the active modes can be an alternative in a compact charging area.
- All sectors reflect faster network speeds when charging is implemented, with the average speed across the entire network going from 39.6 km/hr to 43.3 km/hr (an increase of nearly 10%). The strongest results are in the north sector (a 25% increase from 37.6 km/hr to 47.3 km/hr), reflecting the combined effects of charging on the Harbour Bridge, mode change to the Busway and speeding up the local network.
- Car and public transport travel times to key employment centres show strong improvements. The car travel times improve on average by about 12% (dropping from 18 minutes to 16 minutes), a significant improvement on the 2001 estimate of 25 minutes, reflecting the combined effects of increased investment and the congestion-reducing charge. Public transport trip times reduce by about 14% from about 50 minutes to about 43 minutes as a result of improved network speeds.
- Vehicle trip reduction and re-distribution because of the charge markedly improves the Level of Service (LOS) on roads in the region, with higher proportions of good LOS A/B (free-flow: from 57.6% to 61.8% of the network) and lower proportions of roads with poor LOS E/F (stop-start: from 20% to 13.2% of the network).

Analysis has also been undertaken on the expected changes in times for some typical trips in the AM peak in 2016. The analysis shown in the table below demonstrates that there are some trips for which the congestion scheme is expected to have hugely significant benefits (cutting trip times by up to 50%).

Table 5: Specific trip time changes: Congestion Scheme

Car trips	'No-pricing' 2016 (shortest trip)	Congestion Scheme 2016 (shortest trip)
Travel times, mins	Time, mins	Time, mins
Takapuna to Airport	46	31
Albany to CBD	37	20
Panmure to CBD	19	17
Mangere to CBD	25	22
Henderson to CBD	32	23
Henderson to Takapuna	33	32
Mt Wellington to Takapuna	29	27
Henderson to Mt Wellington	43	33
Ponsonby to Parnell	11	10

5.3 Public transport analysis

The Ministry worked with ARTA and ARC to undertake more detailed analysis on public transport in the context of road pricing in Auckland, in order to:

- ascertain the extent to which current and planned passenger transport networks can provide a reasonable alternative to using a private car to travel into the charged area
- identify the additional infrastructure and services required (if any) above what is planned to be funded and provided over the period (to 2016).

5.3.1 The Passenger Transport Network Plan

The Passenger Transport Network Plan (PTNP) networks and services (those that can be funded through existing and planned funding sources) were used as the base passenger transport networks for the analysis. The PTNP aims to achieve the PT mode share target set out in the Regional Land Transport Strategy (RLTS) of 11% (100 million passenger trips annually) by 2016 based on:

- **Rapid Transit Network (RTN)** provides direct frequent services linking the CBD to the regional growth centres. The RTN is designed to operate separately from road traffic and be unaffected by congestion. Its main function is to provide congestion relief and regional accessibility supported by high quality interchanges.
- **Quality Transit Network (QTN)** connects regional centres to each other with high priority given to buses so that services can be operated frequently and reliably.
- **Local Connector Network (LCN)** provides regional coverage, connecting suburbs to local centres, and provides feeder services to QTN and RTN interchanges.
- **Targeted services** which serve niche markets and special needs such as the Total Mobility programme and school bus services.

5.3.2 General indicators

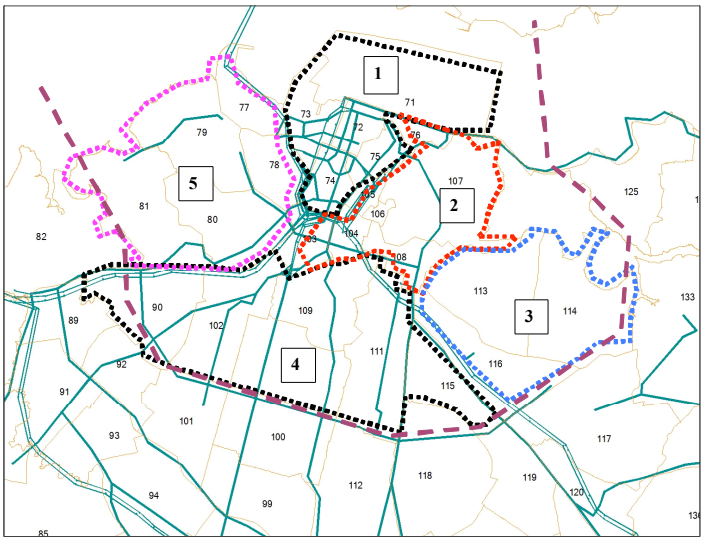
The indicators in Table 5 (previous page) show:

- a strong improvement in PT mode share in the peak period, from the 11% RLTS target to 15%.
- some improvement in region-wide PT travel times, due to improved network road speeds and correspondingly higher PT speeds.
- a greater improvement in travel time to employment centres because of the dominance of the CBD demand for PT.

5.3.3 Detailed sector analysis

The charged area was split into five sectors to produce the public transport results, to ensure that the CBD did not dominate the model results (due, for example, to its high level of PT service). The five sectors are shown below in Figure 3. The sector numbers are shown in boxes while the un-boxed numbers are the Revised Auckland Regional Transport (RART) model zone numbers. Further details are set out in the Passenger Transport Workstream Report.

Figure 3: Detailed sector analysis in charged area



Key points to note on the five sectors:

- **Sector 1** is the CBD; mainly employment with significant RTN and QTN PT services. It is the part of the study area most accessible to the rest of the region by all PT modes, with direct RTN and QTN services to all parts of the region terminating at major interchanges, such as Britomart, Albert Street and Midtown.
- **Sector 2** is the Newmarket and Parnell mixed area which has good PT. It is well connected to the rest of the region, with direct RTN and QTN services passing through. Newmarket is the most accessible rail station in the region, in terms of population within 30 minutes rail-travel time, and by 2016 a new station will be opened near Parnell. The Central Connector bus corridor passes through this zone.
- **Sector 3** Remuera is mainly residential with radial PT services. This sector is connected to the rest of the study area via QTN and LCN services – mainly cross-town routes such as the 007 service and QTN routes running along Remuera Road. There is reasonable direct connectivity to the east of the region but transfers would be required to access most other parts of the region.

- **Sector 4** is the south part of the charged area; mainly residential with radial PT services. This sector is well connected to the CBD, with radial QTN services along Dominion and Mt Eden Roads and to the west by the RTN rail service. RTN and QTN services along the southern rail network and Great South Road provide good connectivity to the south.
- **Sector 5** is the western and Ponsonby areas with good PT along the south edge. This sector is well connected to the north by QTN services running along Ponsonby Road and a very high level of QTN services along Great North Road to the west and northwest of the region. Cross-town services also provide good PT access to the east and the central isthmus.

A detailed analysis of the total generalised cost of PT[5], and relative total costs and travel times of private car and PT for each of these five sectors is shown in Annex 1 (2016 AM peak period 7-9am). There are three main points shown by the analysis:

- Most parts of the region can access each of the five sectors in the charged area reasonably well (some better than others). Most of the region has good access to the CBD and Newmarket-Parnell (measured in terms of generalised cost).
- In the absence of pricing, the average generalised cost of travel in 2016 to regional growth centres by car and PT would be 507 and 676 cents respectively (in 2001 dollars). PT is 1.33 times more costly than car travel in the non-priced environment, but when the congestion charge is added the generalised costs across the region (not just to regional growth centres) are approximately equal. That is, if a $6/day charge were implemented then most of the Auckland region would be able to access all five sectors in the charged zone at approximately the same generalised cost[1] whether they choose a car trip or a PT trip. There are exceptions that would be able to be addressed in a detailed design exercise, assuming that funds from the scheme would be applied to improving public transport.
- On average, across the region, car trips to the charged area will be faster than PT trips, particularly on short-distance trips because modelled car travel times do not have access, egress, wait or transfer time components (note that there is no allowance for those that do not have a parking spot at their destination). Over longer distances PT travel times become more competitive. Most northern and western parts of the region can access the charged area at approximately the same travel time as private car. Zones close to the charged area have poor PT/car time ratios but potentially provide more opportunity for walking or cycling.

The analysis shows that the main focus of detailed scheme design would need to be on improving relative travel times between car and public transport trips. The structure of the PTNP would not be likely to require significant revision, but any marginal re-design would focus on improving interchange quality and wait times. The main initiative would be increasing service frequencies and making significantly more use of bus priority measures.

A broad assessment of the improvement to the passenger transport service that would be required in order to mitigate the effects of charging indicates a need for about 5% more service kilometres than the current PTNP services. This shows that the PTNP network structure is likely to be robust in a priced environment (similar to that presented in this study), and that while localised PT improvements would be required to provide a real alternative to paying the charge, these are essentially marginal service level improvements (refer Annex 1 for further detail).

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[5] The PT cost used is the generalised cost and includes fare and in-vehicle, waiting, access, egress and transfer time costs. Note that, in the model, 2001 values are used, which means that fares are in 2001 $, as are values of time, the vehicle operating costs used in calculating the car generalised costs, and the congestion charge.

[1] The car driver cost is the travel time plus the vehicle operating cost and parking cost plus the road pricing charge.

6 Household Impacts

6.1 Introduction

In 2016, under a 'no-pricing' (base case) scenario, it is estimated that a total of 1.117 million trips will be generated by households in the Auckland Region over the 6-10am period – an average of 2.1 trips per household. The largest share of these trips will be undertaken in a private vehicle as either a driver (53.8%) or a passenger (15.4%). The remaining trips will be undertaken using public transport (12.3%) or walking or cycling (18.5%). The most common reason for these trips will be travelling from home to work (44.3%) or travelling from home to education (26.6%).

Under the Congestion Scheme, it is estimated that total trips undertaken by households over the 6-10am period will decrease from 1.117 million to 1.107 million – a decrease of 10,300 trips, or 0.9% of the total. There is no change in the number of home-to-education trips undertaken and only a 0.2% decrease in the number of home-to-work trips. These trip purposes are the least discretionary and therefore less susceptible to change. There is a 1.7% drop in home-to-other trips and a 1.8% decrease in non home-based trips but, together, these represent a decrease of only 3,900 trips on the 'no-pricing' scenario.

There is, however, a significant modal shift from the 'no-pricing' scenario. Car driver trips decrease by 10% (-59,900 trips) and car passenger trips by 12.3% (-21,100 trips). At the same time, public transport trips increase by 31.1% (42,700 trips) and walk and cycle trips increase by 13.5% (28,000 trips). The most significant decrease in car driver trips is among commuters, with a drop of 43,400 car driver, home-to-work trips, accounting for nearly three-quarters (72%) of the total decrease in car driver trips. These decreases in car driver and passenger trips are consistent with the increases in public transport and walk and cycle trips. The largest increases in public transport trips are by those travelling to work (up by 37,900 trips). This accounts for 89% of the public transport increase. Similarly, most of the increase in walk and cycle trips is in those travelling to work, with 15,900 more trips (57% of the increase), or to education with 4,700 more trips (17% of the increase)[6].

6.2 Nature of directly-impacted trips

Under a Congestion Scheme, trips may be directly impacted in one of three main ways:

- A trip may be undertaken using a different mode to avoid being charged; eg undertaken by bus instead of car (behaviour change)
- A trip may be undertaken more or less often to avoid being charged (behaviour change)
- A trip may be undertaken in the same manner as usual, but be subject to a charge (no change in behaviour).

In 2016, it is estimated that a total of 150,600 trips, or 13% of all trips under the 'no-pricing' scenario, will be impacted by the Congestion Scheme. The largest share of these trips will be impacted by changing their nature in order to avoid the Congestion Scheme charge. Most behaviour change will occur by changing mode from car driver or car passenger to either public transport or walk or cycle (70,700 trips or 6% of 'no-pricing' trips). A further 10,300 trips (net) will

[6] Note that these results are for the 6-10am period, and are estimated based on the transportation outputs from the 7-9am peak period model.

no longer be undertaken, in order to avoid the Congestion Scheme charge, although it is recognised that some of these trips will be re-timed to occur outside the charging period (6am-10am). The remainder of trips directly impacted will not change in nature (ie, will not change mode or be suppressed), but will be affected by incurring the Congestion Scheme charge (69,600 trips or 6% of 'no-pricing' trips). By purpose, home-to-work trips are the most heavily impacted by the Congestion Scheme, accounting for 72% of all impacted trips (67% of behaviour change and 78% of charged trips). In total, 22% of all home-to-work trips are impacted, either through changing behaviour in order to avoid the charge (11%) or incurring the charge (11%) (see below).

Table 6: Extent and nature of direct trip impacts by purpose - Congestion Scheme 2016

	Total	Home-Work	Home-Other	Non-Home Based	Home-Education	Serve Passenger
Trip Impacts						
Behaviour Change	81,000	54,600	7,800	5,300	7,500	5,700
Change Mode	70,700	53,900	5,500	3,900	7,500	-
Change No Trips	10,300	700	2,400	1,400	-	5,700
Trips Charged	69,600	54,300	4,400	3,800	-	7,100
Total Impacted	150,600	108,900	12,200	9,100	7,500	12,800
Total Not Impacted	966,400	386,400	128,500	75,700	289,900	85,800
Total Trips	1,117,000	495,300	140,700	84,800	297,400	98,600
Trip Impacts: Impact Type as Share of Purpose						
Behaviour Change	7%	11%	6%	6%	3%	6%
Change Mode	6%	11%	4%	5%	3%	0%
Change No Trips	-1%	0%	-2%	-2%	0%	-6%
Trips Charged	6%	11%	3%	4%	0%	7%
Total Impacted	13%	22%	9%	11%	3%	13%
Total not Impacted	87%	78%	91%	89%	97%	87%
Total Trips	100%	100%	100%	100%	100%	100%
Trip Impacts: Purpose as Share of Impact Type						
Behaviour Change	100%	67%	10%	7%	9%	7%
Change Mode	100%	76%	8%	6%	11%	0%
Change No. Trips	100%	7%	23%	14%	0%	55%
Trips Charged	100%	78%	6%	5%	0%	
Total Impacted	100%	72%	8%	6%	5%	8%
Total Not Impacted	100%	40%	13%	8%	30%	9%
Total Trips	100%	44%	13%	8%	27%	9%

6.3 Households impacted

In 2016, it is estimated that 19-32%[7] of households will be directly impacted by the Congestion Scheme through either changing behaviour to avoid the congestion charge or incurring the charge. The largest number of impacted households will change their travel behaviour, predominantly by changing mode (8-14% of households). The remaining households aiming to avoid the charge will do so by changing the number of trips undertaken (2-5% of households). A further 8-13% of households will be directly impacted by incurring the Congestion Scheme charge.

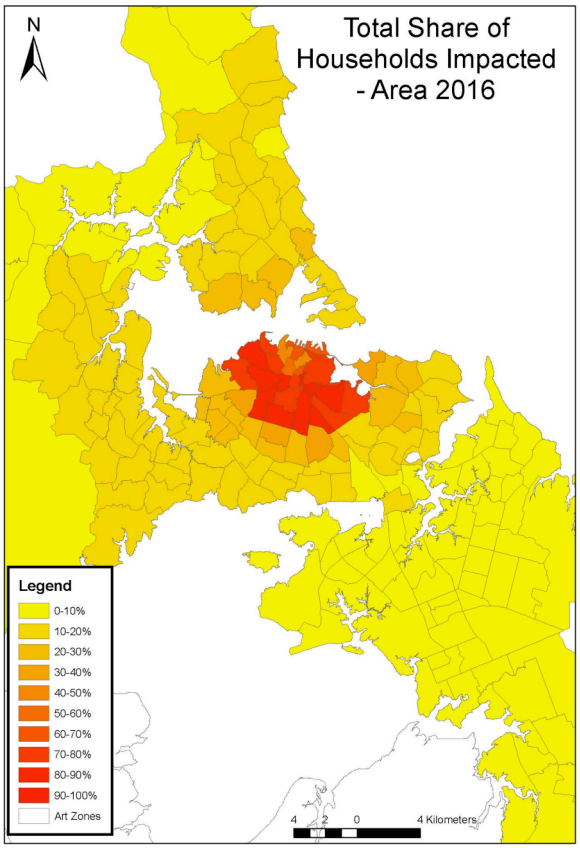
The most commonly impacted family types are couples (23% of all couples households are impacted) and multi-family or non-family households (21%) – in particular, those with working-age adults and/or those in the higher quintile groups. By contrast, households containing older singles and older couples are less commonly impacted. This pattern essentially reflects the strongest impacts on households living and/or working within the Congestion Scheme boundary and travelling during the 6-10am period. Conversely, households less likely to be living within the scheme boundary (poorer households, family households) and/or households where one or more adult members are less likely to be working within the charging area (family households, older households) are less likely to be impacted.

Figure 4 (on the next page) illustrates the geographic spread of the households impacted by the scheme (either by changing their behaviour or paying the charge). Overall, the concentrations of total households impacted by the Congestion Scheme are clearly highest within the charging area boundary. Within this area, a higher share of households are impacted around the outer suburbs (in the range of 60-80%) than within the CBD area (40-60%). This reflects the characteristics of CBD households which are likely to have fewer vehicles per resident and are currently more likely to make un-impacted walk or cycle and public transport trips.

[7] Households impacted have been derived directly from the number of trips impacted. The actual numbers of households impacted cannot be defined precisely and have therefore been derived as a minimum to maximum range. This is because the RART model provides estimates for a typical weekday, when a certain percentage of trips and households will be impacted. However, over the course of a year it may not be the same households impacted every day, even if the same number of households is impacted. Therefore, over time the impact may be spread over more households within the community.

6.4 Financial impacts on households

Figure 4: Share of households impacted - Congestion Scheme



Financial impacts of the Congestion Scheme fall into one of two categories:

- **Out-of-pocket costs:** These are directly incurred costs that are tangible and have a direct impact on the income of a household, including the direct charges of the scheme and changes in vehicle operating costs, public transport fares and parking costs.
- **Utility costs:** These are less tangible and relate to the value of time saved or incurred directly, and the value of either additional trips or trips suppressed directly as a result of the implementation of the scheme.

There are still out-of-pocket and utility costs associated with travelling where there is no road pricing. Overall, it is estimated that the 'no-pricing' cost of travel over the 6-10am period for households that will be impacted by the Congestion Scheme ($3,002 per household per annum) is more than twice that for households that will not be impacted by the scheme ($1,307 per household per annum). There are two main reasons for the differences:

- Car driver trips within the Congestion Scheme area under the 'no-pricing' scenario (ie potentially impacted trips) are longer on average (11.9km) than trips that do not travel into the Congestion Scheme area (8.7km) and therefore incur higher vehicle operating and time costs.

- Car driver trips in the Congestion Scheme area under the 'no-pricing' scenario incur all parking costs while trips that do not travel in the area incur no parking charges at all. The RART model allocates parking costs only to trips which terminate in the CBD or Newmarket area so, by definition, under the Congestion Scheme, 100% of parking costs are incurred by trips that are potentially impacted (as all trips that terminate in the CBD or Newmarket are impacted).

For households impacted by incurring the Congestion Scheme charge, it is estimated that the additional annual average out-of-pocket cost over the 6-10am morning peak period will be $2,218 per annum, or approximately $8.90 per day – consistent with each impacted household incurring an average of 1.5 charges per weekday. This will amount to a 203% increase in out-of-pocket costs for travel in the 6-10am peak period. At the same time, these households will make an annual average time-saving of $131 per annum as a result of travelling on a slightly freer network. It is estimated that these households will incur total additional costs of $2,087 per annum or a 70% increase over total 'no-pricing' travel costs.

For households impacted by changing behaviour (predominantly switching from car to public transport or walk or cycle), out-of-pocket savings are made through reduced vehicle operating costs (-$296 per annum) and reduced parking costs (-$223 per annum). Additional public transport fares are incurred ($409 per annum) but the resulting impact is an overall decrease in out-of-pocket costs of -$110 per annum over the 6-10am period. However, a cost to those choosing to change behaviour is an increased time cost ($538 per annum) due to the switch from private vehicle to slower modes, and also a cost associated with the loss of value of trips which are no longer made ($129 per annum). Overall, those households impacted through changing their behaviour incur a 19% increase over total 'no-pricing' costs, from $3,002 per household per annum to $3,558 per annum for travel over the 6-10am period. These impacts are shown in Table 7 on the next page.

Note that this analysis (including that shown in Table 7) applies to trips undertaken over the 6-10am period only (the period over which the Congestion Scheme charge would apply) and compares the cost of travelling over this period under a 'no-pricing' scenario with the same cost under a Congestion Scheme scenario. In a large number of cases, it is likely that this travel accounts for one-way trips to a destination such as work or school but does not account for the return trip. In reality, the decision of whether to undertake a trip (and, if so, how it is to be undertaken) is likely to consider both the outward and the return legs of the trip and the costs associated with both legs. In the case of trips impacted by incurring the Congestion Scheme charge, only one leg will be impacted by incurring the charge, effectively reducing the impact (in terms of % cost increase) when accounting for return trips. Time savings will double as the network will also be freer on the return leg (assuming that significant shares of repressed trips are not simply retimed).

The net result is that for households impacted by incurring the Congestion Scheme charge, the increase in cost over the 'no-pricing' scenario is 33% when return trips are accounted for, compared with 70% when only 6-10am trips are considered.

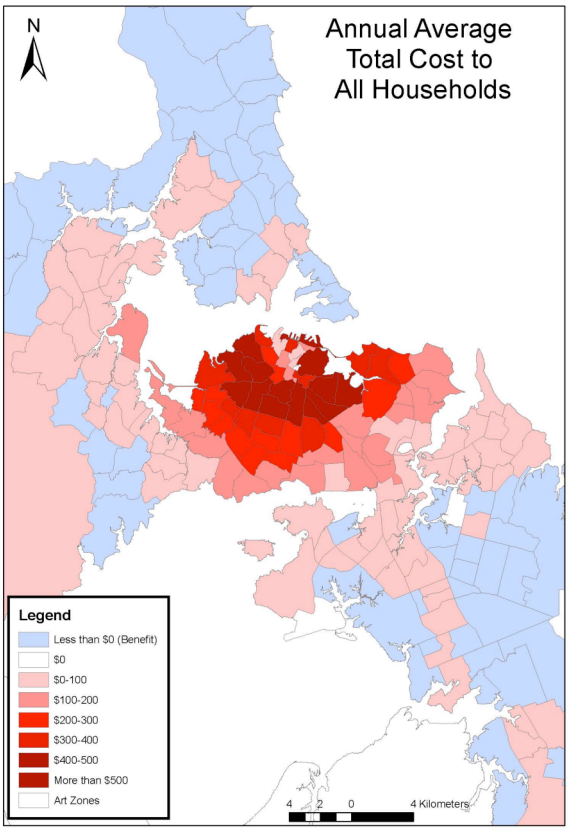
Table 7: Financial impacts of Congestion Scheme on impacted households, 2016

Impacted Households							
	No pricing	Congestion 2016					
		Impacted by Incurring Charge			Impacted by Changing Behaviour		
	Annual Average cost per Household of All travel 6-10am	Additional Annual Average Cost per Household of All Travel 6-10am	Total Annual Average cost per household of All Travel 6-10am	% Increase in Costs from No Pricing	Additional Annual Average Cost per Household of All Travel 6-10am	Total Annual Average Cost per Household of All Travel 6-10am	% Increase in Costs from No Pricing
Out of Pocket Costs							
Scheme Charge	$ -	$2,218	$2,218	na	$ -	$ -	na
Vehicle Operating Costs	$465	$ -	$465	0%	-$296	$169	-64%
Public Transport Fare	$402	$ -	$ 402	0%	$409	$811	102%
Parking Costs	$223	$ -	$223	0%	-$223	-$0	-100%
Total Out of Pocket	$1,090	$2,218	$3,308	203%	-$110	$980	-10%
Utility Costs							
Value of Time	$1,912	-$131	$1,781	-7%	$538	$2,450	28%
Value of Trips Not Made	$ -	$ -	$ -	na	$129	$129	na
Total Utility	$1,912	-$131	$1,781	-7%	$667	$2,579	35%
Total Cost	$3,002	$2,087	$5,089	70%	$557	$3,558	19%
Total Cost (All Households) ($m)	$298	$90	$220	128%	$31	$200	34%

6.4.1 Spatial distribution of financial impacts to all households

Out-of-pocket impacts across all households will be highest (in excess of $500 per household per annum) for those located immediately inside the Congestion Scheme boundary; ie Westmere, Balmoral, Mt Eden, Epsom, Remuera. These areas are all mainly suburban (with a few centres of employment) and furthest from the CBD of all suburbs within the scheme area. Commuters in these areas will have fewer convenient public transport options and may be more likely to incur the charge than change behaviour.

Figure 5: Total annual average costs to all households, 2016



For those living in suburbs closer to the CBD (and a range of employment centres), more walking, cycling and public transport options are likely to be available to avoid incurring the charge. While these households may bear additional fare costs these will be small compared to the option of incurring the charge.

When distributed across all households, time costs are a net benefit throughout the region, since travel time is reduced. This is due to the overall reduction in the number of vehicle trips under the Congestion Scheme, resulting in a faster network. However, for much of Auckland City (particularly suburbs within, and on the periphery of, the charging area border) additional time costs are incurred as a result of car drivers switching to slower public transport or walk or cycle trips and some households choosing to suppress trips in order to avoid paying the charge. Total cost impacts (out-of-pocket costs and time costs or benefits) are shown in Figure 5.

As the Figure 5 shows, when out-of-pocket and time costs are combined, households in the outer suburbs of the Congestion Scheme boundary (Westmere, Balmoral, Mt Eden, Epsom, Remuera) are the hardest-hit financially, incurring average annual costs in excess of $400. As with out-of-pocket costs, these households are likely to have fewer public transport and walk or cycle options and are therefore more likely to have to incur the charge. Further out, suburbs to the west, south and east of the scheme boundary incur the next highest impact ($200-$400 per annum), while most remaining suburbs within Auckland City incur a tertiary impact ($100-$200 per annum).

Outside of Auckland City, large areas of Waitakere City and Manukau City receive a low degree of impact ($0-$100 per annum). It is notable that, with the exception of some suburbs to the south (closest to the CBD), most suburbs in North Shore City receive a benefit as a result of the Congestion Scheme. This is likely to be the result of frequent, fast and reliable public transport

options for the residents of North Shore City via the Busway, and the effectively lower fare levels with integrated ticketing.

6.4.2 Impacts of out-of-pocket costs

The financial impacts of a road-pricing scheme are of most concern when the out-of-pocket impacts are relatively high and the ability to pay is low. There are four main areas within the region that have relatively high levels of deprivation and relatively high out-of-pocket costs under the Congestion Scheme; Rosebank, Waterview, Wesley and the eastern CBD. Of these areas, Rosebank is predominantly light industrial and the eastern CBD is a mixture of commercial and apartment dwellers – a large proportion of whom are students. Waterview and Wesley, however, are predominantly residential and recognised as lower socio-economic areas within Auckland City. A larger general area covering the central western area of the Auckland isthmus is the next greatest concern, subject as it is to either high deprivation and medium impact or medium deprivation and high impact. This is clearly the wider area on which measures to moderate social impacts would need to focus if a decision was made to proceed.

Out-of-pocket costs can also be contextualised by considering additional out-of-pocket costs as the result of a road-pricing scheme in relation to household income. Overall, additional out-of-pocket costs resulting from the Congestion Scheme would amount to 1.8% of the average household income (of all households in the region).

Table 8: Distribution of out-of-pocket cost impacts (as a share of household income)

Congestion 2016			
	Number	% All Households	% Impacted Households
Very Low Impact (0-1% of Household Inc)	10,600	2.0%	10.7%
Low Impact (1-2% of Household Inc)	47,500	9.2%	47.8%
Medium Low Impact (2-3% of Household Inc)	8,900	1.7%	9.0%
Medium Impact (3-4% of Household Inc)	19,800	3.8%	19.9%
Medium High Impact (4-5% of Household Inc)	12,500	2.4%	12.6%
High Impact (5+% of Household Inc)	-	0.0%	0.0%
Total Impacted Households	99,300	19.1%	100.0%
Total Not Impacted Households	419,700	80.9%	na
Total	519,000	100.0%	na

Table 8 shows that for 92.1% of all households (and almost 60% of impacted house-holds), the additional out-of-pocket impact of the Congestion Scheme is either nil, very low or low (2% or less of net household income). Six percent of all households (26% of impacted households) incur an additional out-of-pocket impact in the range of 3-5% of net household income. None of the defined household types incur an additional out-of-pocket impact in excess of 5% of net household income.

7 Economic Impacts

7.1 Introduction and approach

The economic impacts workstream featured consultation with firms and industry associations representing businesses, retailers and road carriers in Auckland, along with Auckland International Airport Limited (AIAL) and Ports of Auckland Limited (POAL).

It is important to note that although the consultation with firms and industry associations was in some cases carried out by way of survey, these surveys were not designed to be statistically valid. Survey tools were used as an efficient way of gathering information from a broad cross-section of the Auckland business community; however, the results should not be relied upon as statistically robust.

7.2 Overall findings: impacts of congestion

Congestion is a major issue for a wide range of enterprises in Auckland. In particular, it is clear that road carriers, as a group, are adversely impacted by congestion. Traffic congestion is significantly reducing their productivity and profitability. Road carriers are increasing their fleet size, extending their hours of operation and bearing increased employment and vehicle-related costs (eg fuel) because of congestion. Productivity and profitability are reduced accordingly.

Congestion also affects businesses and retailers, but the impacts are less than those on road carriers. Congestion affects the ability of businesses to reach their clients. It also impacts on the behaviour of shoppers who, because of congestion, decide to shop closer to home.

Because congestion increases the cost of travel, it also affects the willingness of people to travel to or through congested areas, to get to their place of work. Anecdotal examples suggest that some employers, because of their location, are finding it harder to attract workers because they are not willing to endure the congested commute.

Based on the comments above, it might be concluded that the impacts of congestion are all negative. However, information obtained from a range of firms in Auckland, indicates that, in fact, congestion creates winners and losers. A business in one location may lose customers because of congestion, but those customers go elsewhere and other businesses gain. The same appears to be happening in the labour market; some workers will choose to work closer to home, which benefits some businesses and disadvantages others.

Several other points regarding congestion were also frequently raised:

- Congestion itself is not as major an issue for many businesses and retailers, as might have been expected. It is, however, the interaction of congestion with other factors that creates major concerns. A good example of this is supermarkets, especially those in residential areas that, because of resource planning consent requirements, have had to decrease the time during which deliveries can be accepted. Congestion is making it harder to work within these parameters.
- Auckland region's economy outpaced New Zealand's growth in 2006. The Regional Gross Domestic Product (RGDP) grew at an annual rate of 3.1% for the year ending 2006. In contrast, New Zealand's economy exhibited a growth rate of 2% for the same

year[8]. This has been putting pressure on labour markets, the property market and costs generally. In some cases congestion has encouraged workers to find employment closer to home – an option available to them in a buoyant labour market.

- The availability, or lack, of (affordable) parking, particularly from the perspective of retailers, is an important consideration. De-congesting roads will not assist retailers if their customers have nowhere to park their cars. To a lesser extent, the availability and price of car parking also impacts on the ability of all businesses to attract and retain employees.
- Congestion alone does not cause firms to change location, although it is a factor that rates highly alongside other considerations.

Respondents were also asked to comment on the relative value they place on travel time savings and reductions in trip time variability. The results are fairly consistent. Businesses value travel time savings about 50% more highly than reductions in trip variability.

Specific findings in relation to the Congestion Scheme are discussed below. All businesses were asked to consider what the implications for them would be if a Congestion Scheme was introduced***. For the purpose of this work the Congestion Scheme was described to businesses as reducing trip times by an average of 25%. This was purely for illustrative purposes.***

7.3 Road carriers

General

The vast majority of road carriers consider that congestion has increased operating costs as a result of having to travel on congested roads and/or divert onto longer but less congested routes. Eighty-six percent thought fuel costs were higher, 47% RUC and 72% other vehicle operating costs.

Most respondents concurred that the Congestion Scheme would reduce travel times and travel time variability. However, some thought the Congestion Scheme would result in increased travel times and trip time variability suggesting that the Congestion Scheme might induce some road carriers to divert around the charging zone.

Operating Costs

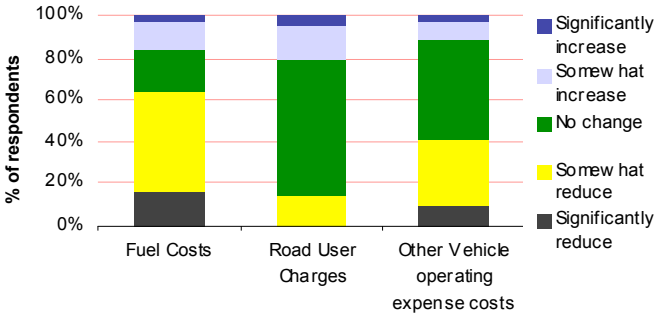
The impact on operating costs, assuming that the Congestion Scheme reduces average trip times by 25% and based on the survey responses, is shown in Figure 6.

64% of responses indicated fuel expenditure would fall, with 16% contemplating a significant reduction. 41% indicated that other vehicle operating costs would also fall, with 9% indicating a significant reduction.

More responses (21%) indicated an expectation that RUC would increase than those who thought it would fall (14%). This may suggest that road carriers expect to make more trips. It may also be indicating an intention by some road carriers to avoid the charge zone and drive around it, rather than through it.

[8] *Auckland Business & Economy 2007,* prepared by NZIER for Auckland Regional Council 2007, http://www.arc.govt.nz/albany/fms/main/Documents/Economy/Economic%20development/Business%20and%20Economy%20Report%202007.pdf

Figure 6: Impact of 25% trip time reduction



Labour market

Nearly half of the responses indicated that employment costs would be expected to fall in the light of a 25% reduction in travel times, and 49% indicated a reduction in operating hours. However, 19% of responses expected it to be harder to attract and retain employees.

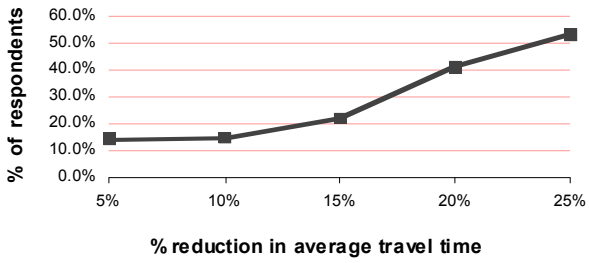
Business Location

Almost all respondents (98%) indicated that a 25% reduction in average trip times would have no impact on business location. That is to be expected since, leaving aside all other considerations, if it takes less time to move around Auckland, choice of location becomes less relevant.

Productivity

Road carriers' willingness to pay $6 for reduction in travel time is shown in Figure 7.

Figure 7: Willingness to pay $6 for travel time reduction



In theory, a Congestion Scheme could be expected to have beneficial productivity effects for road carriers. This appears to be borne out, as seen in the following:

- 26% of respondents indicated they would reduce their vehicle fleet
- 49% would reduce operating hours
- 60% would increase the number of deliveries
- 55% would increase the frequency of deliveries.

Profitability

Unless the market for road haulage grows, it is unlikely that a net 34% of road carriers as a total group would benefit from increased turnover. Based on the survey results, the assumed 25% reduction in travel times would have a positive impact on the profitability of road carriers: 64% would expect fuel costs to reduce, 41% would expect other vehicle operating costs to reduce and 48% would expect employment costs to fall.

However, the highly competitive nature of road transportation means that cost savings will, at least to some extent, flow through into lower cartage rates. This is still a benefit to New Zealand as a whole but the full extent of the benefits may be shared between road carriers and their customers.

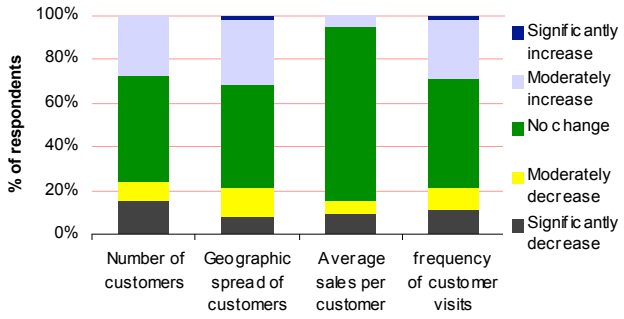
7.4 Retailers

General

Discussions with retailers suggest that while traffic congestion has some impact, it is not as significant an issue for retailers compared to parking and occupancy costs. Approximately half of the respondents were sceptical that the Congestion Scheme would reduce congestion, although 34% thought there might be an improvement in travel time variability.

Customers and revenue

Figure 8: Perceived impact of 25% travel time reduction



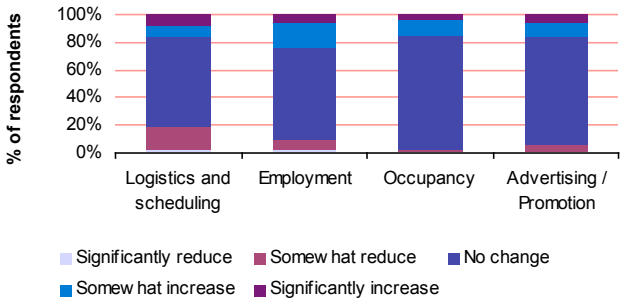
Retailers were asked to comment on the number of customers and where they come from, average sales, and the frequency of customer visits. Their responses are shown in Figure 8.

In response to the hypothetical scenario in which average trip times were reduced by 25%, 65% of survey respondents indicated that there would be no change in turnover, 18% thought it would increase their turnover and 18% thought it would reduce their turnover.

The results indicate that retailers believe that the Congestion Scheme would be positive for their business. In particular, 28% of retailers thought the number of customers would increase, and 30% of retailers indicate the frequency of customer visits would increase.

Operating Costs

Figure 9: Impact on operating costs



Only 20% thought that a reduction in travel costs would be likely. Most respondents expected no change in operating costs across travel costs (65%), occupancy costs (82%) and advertising and promotion costs (78%).

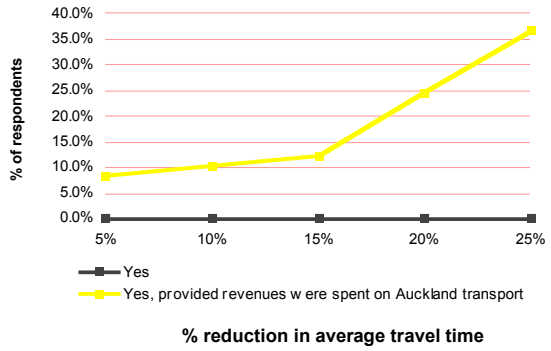
Some thought that occupancy costs would increase (15%).

Labour market

Sixty-seven percent of retailers expected no change in employment costs as a result of a Congestion Scheme, with 24% expecting employment costs to increase. There was a relatively even balance between those who thought a Congestion Scheme would make it easier to attract and retain employees and those who thought it might be harder.

Productivity

Figure 10: Willingness to pay $6 for reduction in trip time



The survey findings observed resistance to the Congestion Scheme charge amount. Nearly 63% reported that they would be unwilling to pay $6 to effect a 25% reduction in travel time.

The graph in Figure 10 shows the willingness to pay $6 for a reduction in trip time.

Forty-eight percent of retailers indicated a need to support the local retail area promotion if the Congestion Scheme was implemented, while 32% expected a greater need to improve retail attractiveness through store refurbishments etc.

Profitability

The survey indicated that the Congestion Scheme is not expected to have significant impacts either way on the profitability of the majority of retailers as the majority of respondents reported no changes to turnover and costs.

Retailers' location

Fewer respondents indicated that they would open up new branches to be closer to customers if a Congestion Scheme was in place, than in a 'do nothing' scenario with increased congestion. This is consistent with the literature and international experience on the effects of road-pricing schemes. In particular, Safirova et al (2006) reported modelling that showed retail firms in the charge zone benefited from the lower costs of shopping travel that resulted from decreased congestion. The NZIER study identified that congestion charging freed up road space and enabled more productive activities to expand. In addition, there can be agglomeration benefits from a reduction in commuting time and from increased employment density. Given that a large proportion of central area retailers service local employment and residents, reduced congestion arising out of the scheme would lead to a reduced need for suburban retail branches to service customers.

7.5 Other businesses

General

The majority of businesses surveyed believe that the Congestion Scheme would reduce congestion in Auckland. Compared to the responses from road carriers and retailers, other businesses expect the impact from a Congestion Scheme to be more significant. This is likely to reflect, largely, their location in the CBD and Newmarket, whereas the geographic distribution of other respondents was wider.

Customers

The proportion of respondents (22%) that expect the number of customers to increase is somewhat higher than the proportion (15%) that expect the number of customers to fall. However, 15% of responses indicate that revenue per customer is expected to fall whereas only 5% expect average sales per customer to increase. This appears to suggest that while reduced traffic congestion will enhance access to customers, the Congestion Scheme could adversely impact on the level of expenditure by customers. It needs to be remembered, however, that only a minority of business customers are individuals who would be directly impacted financially by the Congestion Scheme.

Operating costs

With a 25% reduction in travel times, 43% of respondents expect business travel costs to reduce and 19% expect them to increase. More respondents (15%) expect occupancy costs to increase than those (8%) who expect them to decrease. Nearly half (48%) of respondents thought that the reduction in travel times (and, by implication, congestion) would increase the general amenity of their business location.

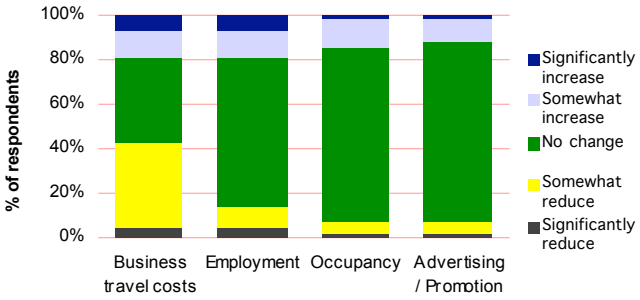
Labour market

The ability to attract and retain employees was expected to be easier for half of the businesses responding to the survey. Only 17% thought recruitment and retention would become more difficult.

A more mixed picture emerges, however, in terms of the impact on employment costs. Of the responses, 19% indicated they expected employment costs to increase while 14% expected them to reduce. There appear to be two factors influencing these results. Firstly, a number of businesses noted that the $6 congestion charge would probably find its way into the mix of considerations influencing wage demands. At the same time, if a reduction in traffic congestion helps to make the CBD (and Newmarket) a more attractive employment destination, then the pressure to reflect the congestion charge in remuneration may be less. For those indicating an expected reduction in labour costs, it is possible that this is a function of expected changes to business operations in the light of reduced congestion, since approximately 10% of business respondents indicated that their hours of operation would reduce if travel times fell by 25%.

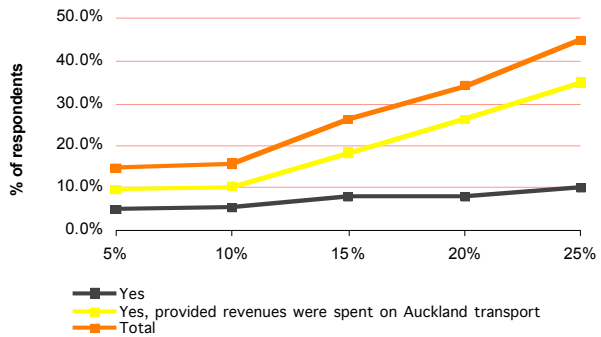
Productivity and profit

Figure 11: Impact of 25% reduction in trip time



The response from businesses to the Congestion Scheme and scenario of a 25% reduction in travel times painted a rather mixed picture in terms of the impact on business productivity and profitability. Some businesses expected turnover to improve while others expected it to fall. Equally, some businesses expected costs to increase while others thought they would fall. The conclusion that resulted from this was that reducing traffic congestion would create a situation of winners and losers. The net effect was unlikely to be substantial in either case. The impacts of reduced travel times on various expenditure items are shown in Figure 11.

Figure 12: Willingness to pay $6 for reductions in travel time



Businesses were asked to indicate whether they would be willing to pay $6 to achieve reductions in travel times (Figure 12). It appears that a greater reduction in travel time needs to be achieved in order for businesses to feel that a $6 charge is warranted.

Business location

For roughly 30% of all businesses located in the CBD and Newmarket the current level of congestion was likely to be an issue causing businesses to consider relocation. In light of the hypothetical 25% reduction in travel times, the proportion of businesses likely to consider relocating is somewhat less.

7.6 General economic effects

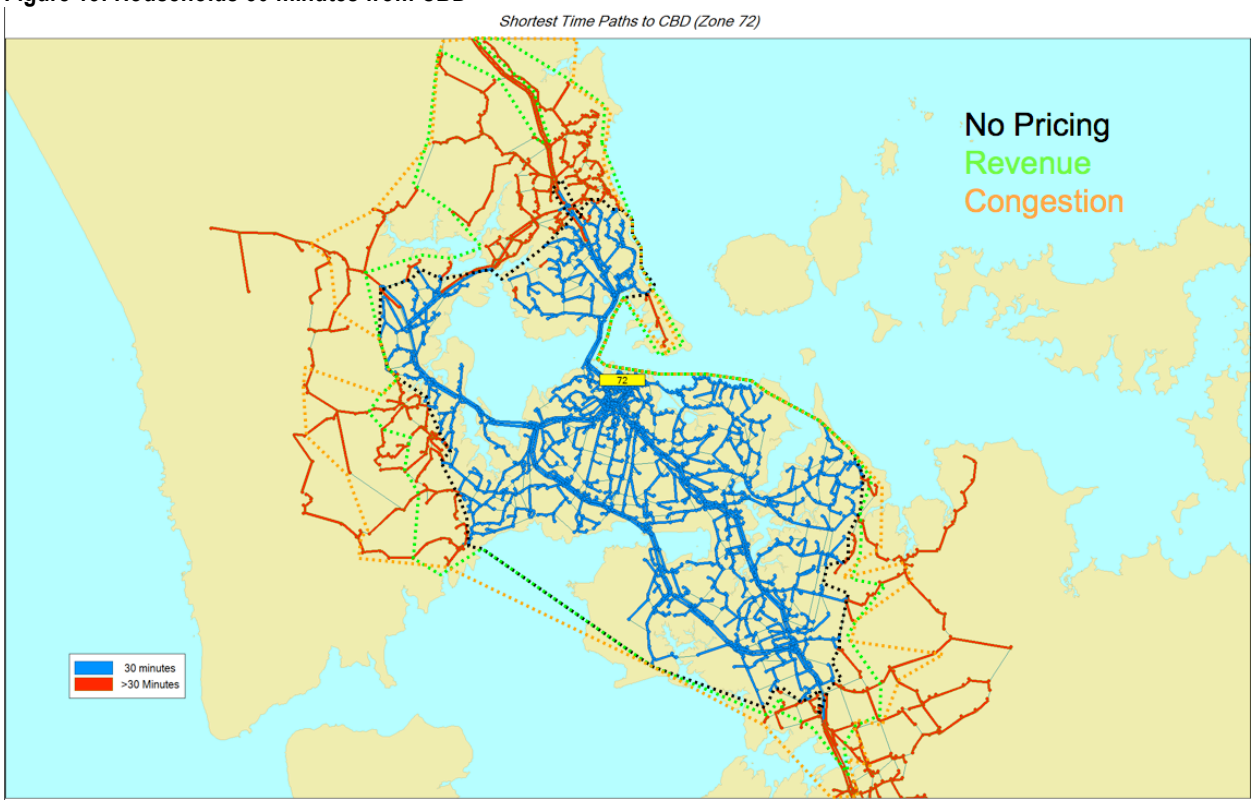
NZIER's work on international findings on the broader economic impacts of congestion charging draws attention to the role that accessibility (reduction in journey times) plays in fostering inter-industry linkages, growth and development synergy within a regional economy. Together, these impacts have been termed the 'economies of agglomeration', and drive benefits such as thicker labour markets (ie better matching of workers to jobs), better links between producers and suppliers, and knowledge spillovers from local contacts. The Eddington Report to the UK Government[9] estimates that a large scale 10% reduction in journey times for car travel across the country has the potential to raise national productivity in the UK by 1.12%.

International evidence[10] is that these agglomeration benefits are highest within a 40-minute travel-time zone from a CBD, and that populations of areas that are 60 minutes drive-time from a CBD have average levels of productivity that are typically only 25% of those of populations that are 30 minutes drive-time from the CBD. Figure 13 overleaf shows the extent to which the Congestion Scheme increases the catchment that is 30 minutes from the CBD in Auckland – with an increase in the number of households that can access the CBD within 30 minutes travel-time at peak times in 2016 from an estimated 311,000 (60% of all households in the region) to 452,000 (87% of all households). This provides a strong indication of the extent to which de-congesting the network could contribute to increased productivity levels in Auckland.

[9] *Transport's role in sustaining the UK's productivity and competitiveness*, http://www.dft.gov.uk/162259/187604/206711/volume1

[10] Grimes, A., (2007), 'Transformative Transport: Transport and Economic Transformation, Presentation to 'Transport – The Next 50 Years' for Ministry of Economic Development

Figure 13: Households 30 minutes from CBD



As noted earlier in this section, international experience has shown that businesses respond dynamically to road-pricing schemes, a point that has been borne out in the responses we received to the surveys of businesses in Auckland, which showed that they were thinking dynamically (eg retailers saw there might be less need to open new branches, road carriers thought they might be able to reduce operating hours). The overall conclusion we can draw is that economic impacts at a macro-, micro- and business-sector level are likely to be fairly neutral, or perhaps slightly positive, depending on how the revenue is allocated and spent. There will be winners and losers and in many cases the impacts on a particular firm or group of firms are likely to be marginal. Impacts on Auckland International Airport and the Ports of Auckland, two significant businesses that we talked to directly, are illustrative of this:

- **Auckland Airport:** Analysis undertaken for the Airport indicates that over 70% of frequent domestic and international air travellers who live in Auckland travel from the North Shore or central Auckland suburbs. The majority of these people are likely to travel in the charging zone to get to the airport. In the Airport's view, a $6 or $3 charge is very unlikely to influence their decision whether or not to travel. It is also unlikely to influence whether or not they choose to use public transport to get to and from the airport. A charge of $6 or $3 is a relatively small proportion of a taxi fare to and from destinations within the charging zone and, equally, is a relatively small proportion of airport parking charges. The Airport company is concerned about access to the airport. Any road charging option which improves access would be viewed as a positive initiative. However, the Airport company is somewhat sceptical as to the effect that a charging scheme might have on reducing congestion at existing bottlenecks outside the charge zone, including the approaches to the Mangere bridge, in particular, but also SH20.

- **Ports of Auckland:** The majority of traffic to and from the port is during normal business hours and the busiest time is around 10-11am. By implication, a significant number of trucks entering and leaving the port are likely to incur the $6 congestion charge. However, because this leads to significant reductions in motorway traffic between the CBD and south Auckland, the benefits in enhanced productivity could be expected to outweigh the cost of the congestion charge, at least for the majority of road carriers. Ports of Auckland also made the point that the scheduling of trips to and from the port is influenced by the needs of the customers of road carriers and, in the case of the ports, the timing of ship arrivals and departures. The $6 charge is unlikely to materially affect these factors. Ports of Auckland operates three shifts a day and about half of port personnel are on shift work. The night shift ends, and morning shift begins, at 7am, which means that employees in both shifts would incur the $6 congestion charge if travelling to work by car. Most non-shift employees would also incur the $6 congestion charge. For some employees, this additional cost might be an issue and, accordingly, the Company considered that there was some possibility that employees might factor this into wage negotiations.

Finally, it is useful to consider the overall economic costs of congestion, and the extent to which the Congestion Scheme could reduce those costs. The costs of congestion are seen to be a significant drain on the Auckland region, as outlined earlier in the Report, and covered extensively in the ARPES 2006 study. Relatively recent estimates have also been compiled for the Ministry's (2005) 'Surface Transportation Costs and Charges Study'. This estimated the cost of congestion in Auckland at $701 million per year (in 2002 dollars), broken down into $320 million for peak congestion and $381 million for off-peak congestion. This suggests a figure well in excess of $1billion in 2008 dollars. The Congestion Scheme will reduce these costs, but will not eliminate them. This is because the methodology used estimates the costs associated with delays imposed by congestion compared with what travel times would be in the total absence of congestion. The transportation results show that 13% of the network will still be congested with the introduction of the Congestion Scheme, which, while a significant reduction from the 20% congested in a non-priced situation, will not eliminate all the costs associated with delays.

8 Environmental and Land-Use Considerations

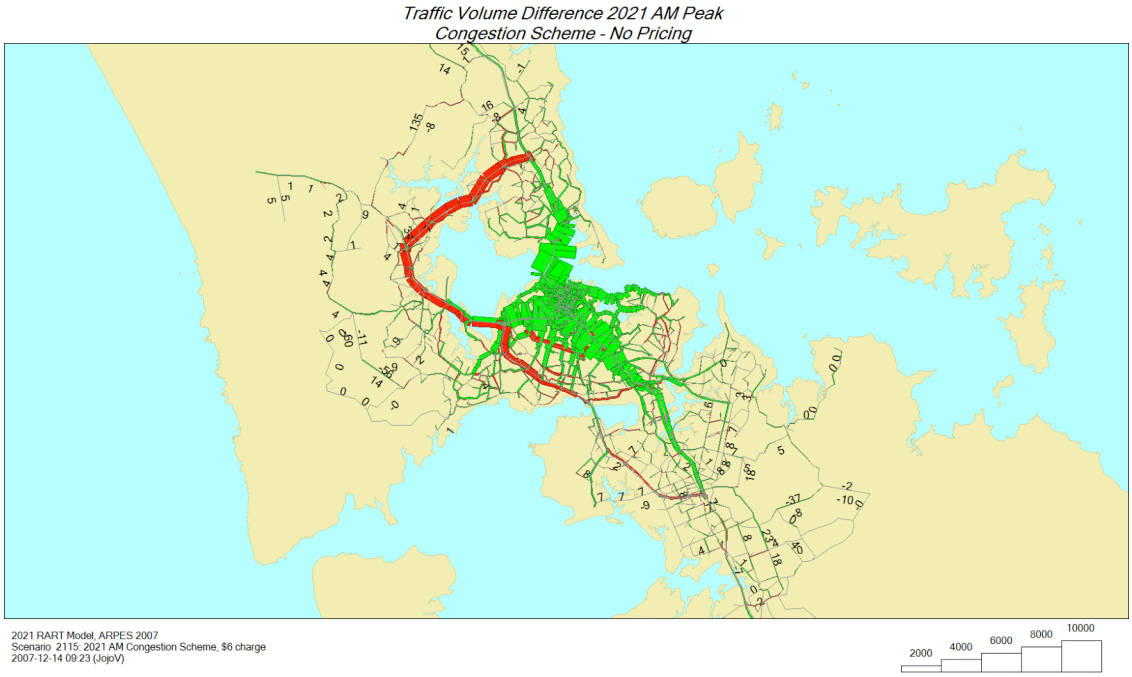
8.1 Approach for environmental analysis

In general, the evaluation of the environmental implications of the schemes primarily relies upon outputs of the Auckland Regional Council's RART model. For the most part, the environmental parameters assessed are linearly related to traffic volumes. In other words, the greatest effects are expected during the peak period, when traffic volumes and exposures are highest as the commuting population moves around the city. The schemes are assessed against the 'no-pricing' scenario, with most figures expressed as percentage change over the modelled 'no-pricing' scenario. A positive percentage represents an improvement over the 'no-pricing' scenario, while a negative percentage represents deterioration in conditions[11].

8.2 Amenity, severance and noise impacts assessment

The impacts of the two schemes on traffic noise and overall general amenity values were assessed by modelling traffic volumes on 100 selected road links within the region, with a focus on local and arterial links within suburban areas where there is a concentration of community activities (for example, in town centres). This traffic volume modelling was also the basis for the consideration of severance. The model results are shown in Figure 14 below.

Figure 14: Changes to traffic volumes on selected arterial links - Congestion Scheme



The most marked impacts of the Congestion Scheme are predicted in the isthmus area within the scheme boundaries (as expected) and in the North Auckland sector. Significant reductions

[11] In most tables, red and green highlighting has been used to note particular effects. Red cells indicate conditions that are worse than the 'no-pricing' scenario, while green cells highlight measurable improvements in conditions compared to 'no pricing' scenario, generally where a 10% or greater improvement is expected.

in traffic volumes (more than 40%) on the selected links in the central urban area are possible under the Congestion Scheme, improving the quality of the central urban environment significantly. The Congestion Scheme is also predicted to lessen, by up to one third, the considerable increases in traffic volumes that would be seen under 'no-pricing' on main arterials in the North Shore area. However, in the South Auckland sector, the Congestion Scheme would have much less impact on the increases in volumes on key links in 2016 and 2021.

Furthermore, as shown in Figure, traffic volumes are predicted to increase above the level in the 'no-pricing' scenario along the arterials forming the Congestion Scheme boundaries. In the isthmus area, the increases along the St Lukes – Greenlane corridor is particularly evident, along with minor links, particularly in the Panmure / Glen Innes and Richardson / Stoddard Road areas. There is likely to be a need to mitigate the local amenity and community effects of this additional traffic by appropriate upgrading of the street environment.

8.3 Stormwater quality impacts assessment

Road transport activities have an adverse effect on the quality of stormwater running off urban roads and draining into urban streams and coastal waters. Accordingly, the assessment for this study focuses on the benefits or adverse effects of changes in traffic volumes, on sensitive estuarine environments. Catchments with receiving environments that are likely to be sensitive to contaminants from road runoff have been identified and the changes in traffic volumes in these catchments assessed.[12]

Table 9: VKT for catchments with sensitive marine environments – Congestion Scheme

Selected runs	% Reduction (compared to 'no-pricing' scenario) in VKT for catchments with sensitive marine receiving environments	
	2016	2021
Okura	3.58%	2.67%
Upper Waitemata	0.17%	0.29%
Shoal Bay	5.85%	5.10%
Henderson	-3.37%	-2.92%
Whau, Waterview	2.47%	2.77%
Hobson	36.02%	35.54%
Mangere	7.66%	7.17%
Tamaki	4.26%	4.03%
Pukaki	-1.38%	-1.48%
Meola/Motions	41.39%	40.08%

***Note**: Positive %s are reductions in VKT from the 'no-pricing' scenario and negative %s (in red) are increases in VKT.*

The Congestion Scheme sees significant reductions in VKT (and therefore contaminant loads) in the central isthmus catchments lying inside the scheme area (Hobson Bay and Meola - Motions catchments). The reductions in the Hobson catchment and less significant reductions in

[12] Note that road runoff is only one factor that may affect the quality of a marine receiving environment and in some instances, especially catchments with large areas of industrial land use, road usage may not be the dominant cause of contaminant discharge and accumulation.

VKT in the Shoal Bay catchment, improve the contaminant loading to these catchments below 2001 levels. Although the reductions in VKT (contaminant loads) in the Okura, Whau-Waterview, Mangere and Tamaki catchments are smaller than, or an improvement on, 2001 levels, the Congestion Scheme would lessen the potential impacts of increased contaminant loadings which would occur without road pricing. These benefits are offset to a minor extent by small increases in VKT in the Henderson and Pukaki catchments, probably reflecting the diversion of north-south traffic around the isthmus area.

The effects of these increases in contaminant loads on outer catchments could be mitigated by additional stormwater quality treatment of road run-off in the affected areas, leading to an overall enhancement of the sensitive catchments under the road-pricing schemes.

8.4 Air quality impacts assessment

To assess the impacts of the schemes on air quality, the likely vehicle-to-air emissions have been estimated, based on RART-modelled traffic flows, for five urban sectors within the region, and for the region as a whole. The vehicle emission projections take into account the extent to which traffic is congested as well as the road type (motorway or non-motorway) and include assumptions about improved technology. The assessment considers three primary vehicular air pollutants – nitrogen oxides (NOx), particulate matter (PM10) and volatile organic compounds (VOC). The air emission data is expressed in terms of the percentage reduction or increase in air emissions compared with the 'no-pricing' scenario[13].

Table 10: Vehicle related emissions to regional air shed – Congestion Scheme

Emissions to regional air shed (% reductions against 'no-pricing')	Congestion Scheme	
	2016	2021
NOx (kg)	12.6%	10.4%
PM10 (kg)	16.9%	15.4%
VOC (kg)	24.9%	21.6%

Although air emissions are predicted to decrease from 2001 levels by 2016 and 2021 even without road pricing, the Congestion Scheme is expected to result in further reductions in emissions, particularly inside the charging area. The following key points can be noted:

- The most significant positive impacts on air emissions under the Congestion Scheme are in the central isthmus area inside the road-pricing area. The central area will also have relatively high pedestrian levels and an increasing number of high-density residences (apartments). On this basis, the reductions in air emissions in the central area are likely to have particular benefits.
- However, there are also significant reductions in emissions seen in other urban areas outside the road-pricing area, in north Auckland and the rest of the isthmus area, which were not seen in the water quality modelling results.

[13] Only a broad, first order assessment is possible. It is not possible to definitively say that reduced air emissions for a particular sector will lead to improved air quality within that sector (as noted in London). Other factors that would need to be taken into account include the existence of other sources of emissions (such as pollution) and the extent of exposure. In addition, the assessment has been conducted only for morning peak traffic flows which are only a component of the total traffic load in some areas.

- These benefits are offset by increases in emissions in the west Auckland urban areas (however not above 2001 levels). This is likely to be due to north-south traffic diverting around the isthmus area into the west Auckland area, with traffic remaining on the motorway and main arterial road network.

8.5 Greenhouse gas emissions assessment

To assess the impact of the two schemes on greenhouse gas emissions, the average quantity of CO_2 emitted in the AM peak, per vehicle kilometre travelled, was modelled for 2016 and 2021. The figures were then related to an estimate of CO_2 production in 1991 (which is one year different from the benchmark for Kyoto Protocol commitments of 1990). The modelled estimates were also considered in the context of the proposed updated New Zealand Transport Strategy target to halve the per capita greenhouse gas transport emissions by 2040, relative to 2007 emissions. To achieve this target, it was determined that, based on estimated Auckland population figures for 2040, by that year the per capita carbon dioxide emissions from Auckland traffic would have to be reduced to levels which are similar to 1991 levels. The table below sets out an estimate of CO_2 production for the peak 7-9am period in 1991. The data is expressed as a percentage increase over 1991 levels.

Table 11: Estimated changes in CO_2 emissions 1991-2016 and 1991-2021

Production (kg 000s)	1991	2001	No Pricing	Congestion
Estimated 2016 production (kg 000s)	1,024	1,227	1,513	1,365
% increase over 1991			47.8%	33.3%
Estimated 2021 production (kg 000s)			1,590	1,441
% increase over 1991			55.3%	40.7%

The table shows that the Congestion Scheme sees increased production from 1991, although at a rate lower than that of the ‘no-pricing’ scenario. Based on the 2016 and 2021 model results, the 'peak-period' carbon dioxide emissions without road pricing would be around 48-55% higher than 1991 levels. The Congestion Scheme will buffer this increase to some degree – the reduction provided by the Congestion Scheme from the ‘no-pricing’ scenario is around 26-30% of the 48-55% increase above higher levels. In other words, while the Congestion Scheme would not in itself meet this regional transport emissions target as part of the overall UNZTS target (ie reverse the total increases in carbon dioxide levels predicted with no road pricing), it would, significantly, contribute around 26-30% of the reduction needed to meet the target.

8.6 Land use

The Auckland region continues to grow rapidly. The most recent projections from Statistics New Zealand (2006 base year, medium projection series) suggest a regional population in the order of 1.82m by 2026, up from 1.37m in 2006. The main focus of the analysis undertaken to assess the land use implications of the schemes was to consider whether they will assist with, or detract from, the agreed regional land-use strategies, and/or whether longer term land-use changes will undermine the benefits of the schemes. Table 12 on the next page sets out the key points of the analysis undertaken on the land-use implications of the Congestion Scheme.

Table 12: Land use implications of the Congestion Scheme

Growth of RGS centres	As shown in Table, the Congestion Scheme is likely to result in a noticeable reduction in the relative cost of access to Regional Growth Strategy growth areas, by vehicle. This should make these centres much more attractive as business locations.
Business development	The scheme should assist with a higher quality environment for business activities within the core CBD and Newmarket areas (for example, enhanced pedestrian amenity), strengthening the agglomeration process, provided that public transport services are improved. However, the scheme is likely to have an effect on the fringe CBD areas that are not so well served by passenger transport. Areas such as College Hill, Great North Road, Dominion Road and New North Road are generally served by radial public transport routes that head into the CBD and are not as accessible as the Newmarket / CBD hub. Increased costs of vehicle use are likely to have a negative impact on some businesses in these areas. It is therefore possible that there will be some movement of firms from these areas into the more public transport dominated CBD / Newmarket areas, or possibly out to the key east-west routes in the southern part of the isthmus.
Residential development	Residential impacts are likely to be modest. Within the charged area, areas like the CBD and Newmarket are likely to continue to attract households who do not have a car, or do not need to use them on a daily basis. Under the Congestion Scheme, households located outside of the boundary who have school-aged members who travel to schools within the charged area may be less likely to do so, while there may be a disincentive for households with school-age children to live in the charged area. This effect is especially relevant for primary school-aged children as it is more complex for parents to substitute public transport for vehicle use for the trip to school, and then on to work and back. As a result, housing within the boundary of the Congestion Scheme may become less attractive for households with school- aged members, and more attractive for non-family households.
Corridor development	The Congestion Scheme has a positive impact on congestion levels on the north-south arterial roads in the isthmus. This should bring about improved accessibility and reduced pollution effects, resulting in greater desirability of residential development, leading to increased demand as a location for housing and some mixed uses. However, demand for retail activities with a non-local catchment may decrease within the charged area. The opportunities provided by the reduction in traffic pressures should be taken, in order to significantly improve the quality of the street environment of key north-south arterials (in particular, to develop arterial roads like Tamaki Drive and Dominion Road as high-quality, multi-modal boulevards).

Overall, the improvement to the quality of the environment within the charged area and the increased use of passenger transport is also consistent with the goals of the Auckland Sustainability Framework. In fringe CBD areas, off the main public transport routes where retail and service-related activities are more dominant, some relocation of activities out of the charged area can be expected, with land converted to residential use. This may be consistent with regional strategies, provided that the displaced activities can be accommodated in desired growth centres outside the charged area.

Some concentration of households into the charged area (especially arising from the conversion of business land to residential use) is consistent with regional objectives, given the extent of the heritage areas that occur within the charged area. Equally, some displacement of future housing demand to outside the charged area is not necessarily negative, provided it is accommodated in the nodal areas identified by the RGS.

9 Revenue and Financial Modelling

9.1 Introduction and main assumptions

The base tariff for the Congestion Scheme is $6 including GST. A number of assumptions have been made in completing the financial modelling, including about the construction period, regular versus casual-user split, collection costs, depreciation rates, exemptions and revenue leakage (all set to the same value for both the Revenue and Congestion Schemes to assist with comparability). Inputs, such as construction, maintenance and replacement costs, traffic volumes and trip charges, differ between the schemes. Key assumptions for the Congestion Scheme include the level of capital expenditure, traffic volumes and the scheme charge levied per day. In considering capital expenditure, it has been assumed that all transponders will be paid for by the scheme, rather than by the user, and will be replaced every five years. Financing assumptions (ie debt or equity funding) for the initial set-up and construction costs have been excluded from the model. Replacement capital expenditure is funded from scheme-generated cashflows and these capital costs are included in the net present value (NPV) calculation.

Table 13: Congestion Scheme key assumptions

Congestion Scheme			
Average annual daily traffic volumes	**2016**	**2021**	**2026**
Number of charged trips between 6-10am	108,535	114,157	120,070
Daily to annual traffic volumes			
Number of Charging days per annum	250 days	250 days	250 days
Charge per trip (escalated $, GST incl)			
Tariff	$7.87	$8.91	$10.08
On-Board Units (OBUs) in circulation			
Total OBUs	70,303	89,249	109,176
Maintenance costs (escalated $)			
Maintenance costs	5,262,962	5,954,559	6,737,036

Table 14: Congestion Scheme capital costs

Capital Costs (2008$)	**Year 1**	**7-yearly**	**10-yearly**	**20-yearly**
Roadside equipment hardware	$21.3 m		$21.3 m	
Detailed engineering software	$33.9 m		$33.9 m	
Data communications, hardware, software, installation	$15.4 m	$15.4 m		
Staff and call-centre set-up costs	$0.7 m	$0.7 m		
Civil works, foundations	$13.1 m			$13.1 m
Bow wave initial project costs	$3.4 m			

The traffic volumes are based on the RART model and represent the daily number of charged trips as at 2016. The Congestion Scheme is based on charging weekday mornings between the hours of 6am and 10am. The Congestion Scheme operates only on weekdays; therefore the annual traffic volume is the daily traffic volume for 250 charging days (5 x 52 weeks, excluding 10 public holidays). The charge per trip is calculated using the $6 tariff as at the base year for traffic modelling of 2005 and extrapolated to give an approximate charge in 2016 dollars, 2021 dollars and 2026 dollars.

The number of transponders and OBUs required in any given year is a function of the assumed traffic volumes, the percentage of users who hold accounts, the number of OBUs per account, and the number of OBUs to be replaced after battery expiry, etc. It is assumed that in the first year of operation 62,994 OBUs will be purchased, with an average increase of 6% annually over the following 20 years. It is also assumed that all transponders will be replaced on a five-year cycle. The cost of transponders remains flat at $26 per unit in nominal terms, due to the expected decrease, in real terms, of technology costs over time.

9.2 Summary of financial outputs

The Congestion Scheme produces total revenue with a net present value of $1,215m over a 20-year period. This is based on a $6 charge (2005 dollars) including GST and traffic volumes of total charged trips in 2016 of 108,535 per day between 6am and 10am.

The net project NPV is $988 million after operating, capital and replacement costs. The annual net revenue in the first full year of operation is approximately $151 million which increases over the 20-year operating period as traffic volumes increase.

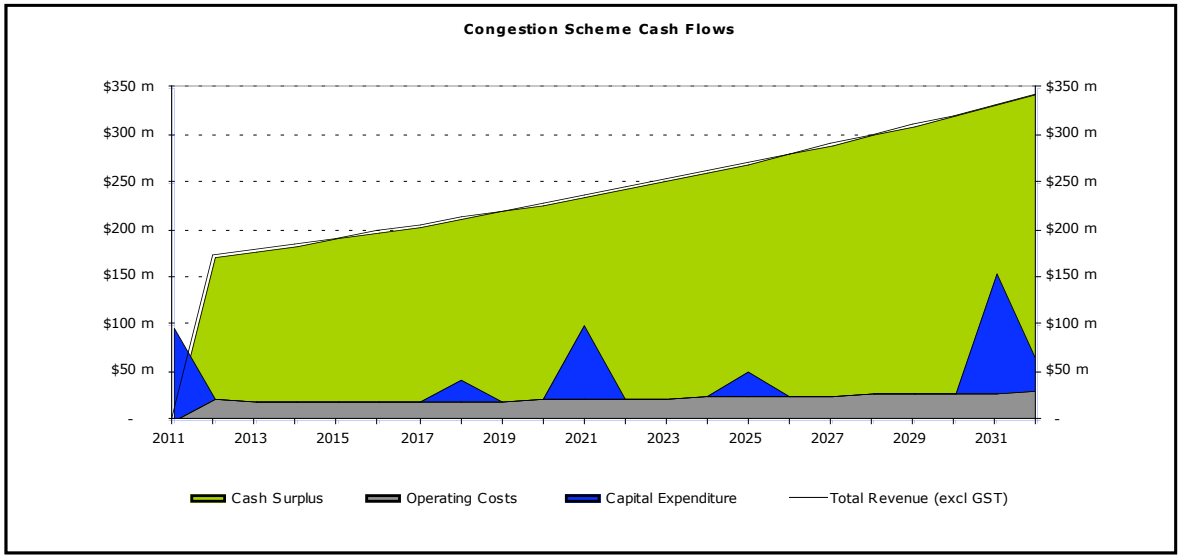
Table 15: Congestion Scheme financial results

Congestion Scheme		
Revenues	**Annual FY 2013**	**Total NPV** (20 Years)
Tariff revenue	$164 m	$1,160 m
Notice fees & other fees	$8 m	$55 m
Total revenue	**$172 m**	**$1,215 m**
Operating expenditure		
Maintenance costs	$5 m	$32 m
Scheme operating costs	$14 m	$82 m
Total operating expenditure	**$19 m**	**$114 m**
Capital expenditure		
OBU capex (escalated)	$2 m	$4 m
Construction capex (escalated)	N/A	$66 m
Replacement capex (escalated)	N/A	$43 m
Total capital expenditure		**$113 m**
NPV of all revenues and costs^		**$988 m**

^ All NPV values discounted at 10% over 20 years and exclude GST.

The cash flows over time are illustrated in the graph below. The figures presented are nominal (undiscounted) figures.

Figure 15: Congestion Scheme cash flows



The Congestion Scheme is able to generate significant revenue as the per-transaction operating cost of the project is about $0.80 (2008 dollars) per transaction, on average, over 20 years (including capital replacement costs) and so the remainder of the charge is net surplus revenue.

Annual maintenance costs are relatively high under the Congestion Scheme, as are construction and replacement capital costs. This is due to a larger quantity of equipment required to monitor both the peripheral boundary and the congestion area, whereas the Revenue Scheme simply monitors entry and exit points along the cordon boundary.

10 Travel Choice and Equity

10.1 Summary of performance

The travel choice workstream investigated the effectiveness of measures such as the use of exemptions and discounts to mitigate potential adverse social impacts of the two schemes. The key study objectives were to understand which measures are more, or less, effective at mitigating social impacts by expanding the travel choice options available to affected households, and which measures are worth considering on the basis that they contribute strongly towards enhancing the equity outcomes and public acceptability. The workstream used desktop research and five focus groups that provided emphasis on those likely to be most impacted by a charge, families with fixed schedules such as school trips, and sectors that were likely to have more flexible travel patterns and differing experiences and views from regular family commuters (students and elderly).

10.2 Key findings from focus groups

Opinions across the focus groups showed a reasonably strong degree of consensus:[14]

- **Severe adverse effects of congestion** – Without exception, all participants in all focus groups spoke of the negative effects of current congestion levels on themselves, on businesses, on their friends and family, and on the Auckland community and economy overall. Workshop participants described:
    - drivers having only five to six daylight hours available outside of peak times to get around the city easily
    - health costs, including tension and anxiety, arising from the frustration of sitting in traffic, and the unpredictability of arrival times
    - work-related costs including, for employees, loss of earnings when they arrive late at work and, for business owners, lost productivity
    - long working days, given the travel time required at each end of the working day and, therefore, a lack of time and inclination to participate in out-of-work activities away from home
    - a reduction in family and community activities, and in socialising and recreation generally, given the time used up (and wasted) travelling.
- **Targeting of revenues to transport improvements** – There was strong consensus that all money raised in any road-pricing scheme adopted in Auckland should be spent in Auckland on transport (either as capital expenditure or as subsidies for public transport). Participants rejected any suggestion that revenue collected from road pricing could be used for anything other than upgrading the transport network.
- **Need for the scheme to change behaviour** – There was strong consensus that any scheme that was introduced would need to influence people's behaviour and target congestion. The Congestion Scheme was therefore viewed more favourably than the Revenue Scheme.
- **Enhanced public transport** – It was put to the group that, before a Congestion Scheme was introduced, significant improvements would be made to public transport.

[14] Note that these are a subset of the issues discussed in the Travel Choices report.

The participants agreed that this was an essential and vital step to provide alternatives to paying the charge and that no scheme should be introduced before these improvements were in place.

- **Flexibility to adapt travel patterns** – Participants expressed mixed views on their flexibility to adopt alternatives to their means of travel. Some people felt that it would be relatively easy to adjust their lifestyles (eg, to change jobs or work from home, to reduce or remove their need to travel into the charged zone) while others did not see this option as a reasonable alternative. The strength of feeling and the greater variation of opinions within groups may have reflected different perceptions about what individual participants could do and what others in the community could do.
- **Incentives and free travel** – There was strong consensus that there should not be incentives or free travel rights granted. It was considered that free travel rights would undermine the whole purpose of the scheme, both in terms of raising revenue and reducing congestion.
- **Exemptions** – There were mixed views on exemptions; three out of the five groups concluded that exemptions were not desirable, while two groups considered that they could play a role. Some people thought that there were sections of the community who could benefit from exemptions or discounts. However, exemptions were also seen as being counter to the objectives of the scheme, in terms of both revenue raising and congestion reduction, and open to abuse (scepticism of enforcement). Exemptions also ran counter to participants' sense of equity and fairness that leaned towards the need for universality in the application of any scheme.

Overall, focus group participants favoured the Congestion Scheme. Participants thought that the scheme had a higher likelihood of changing travel behaviour, which they saw as important. A peak time targeted scheme was seen as more likely to force people to reconsider their travel times, their daily routines (such as working from home), and whether they took public transport or used alternative modes.

10.3 Options to provide travel choice

The focus groups were given a range of options to consider:

- **Revenue targeting** – putting net revenues back into the transport system.
- **Exemptions and discounts** – applying either exemptions to the scheme charge or discounts on the charge to selected user groups.
- **Free travel rights** – issuing a defined number of free trips as a mobility right to affected parties, such as individuals, households and businesses within the region.
- **Incentives and rewards** – can be applied to either regular users or to those who use alternative forms of travel (such as PT) or travel at different times (eg off-peak).

Participants also discussed other voluntary steps they would take to avoid paying the charge. About half of the participants said they would change their work arrangements. Most commonly, they would avoid the peak time by staggering their hours of work (usually by starting and finishing later) or working at home, or a mix of the two. One or two in each group said they would change jobs so that they would not have to cross the scheme boundary. In two of the group discussions (Mangere and Remuera-Meadowbank), a few said they would negotiate with their employers to cover the scheme charge. About half of the participants in each of the groups would change the way they travelled to work, most commonly by using public transport (assuming the services were more convenient, reliable and frequent). Others would carpool or drive to the edge of the scheme area and then walk or use public transport.

The mitigation options were evaluated using focus group responses against a set of criteria that were based upon minimising transactions costs, effectiveness at mitigating impacts, impact on travel behaviour, and ease of understanding, as shown in Figure 16. It should be noted that it is

proposed that exemptions would be introduced for institutional road users (eg emergency services, hospitals), rather than for individual road users, in order to reduce administration costs and minimise abuse and enforcement costs. Overseas experience indicates that targeting institutions rather than individuals helps to decrease the scale of scheme abuse.

Figure 16: Analysis of mitigation options

Mitigation options*	Transactions costs	Effectiveness	Impact	Understanding
Revenue targeting	✔	✔ ✔ ✔	✔ ✔	✔ ✔ ✔
Exemptions and discounts	✔ ✔ ✔	✔	✔ ✔	✔ ✔
Free travel rights	✔ ✔ ✔	✔	✔	✔
Incentives and rewards	✔ ✔ ✔	✔	✔	✔

Note: 3 ticks indicate high, 2 ticks moderate and 1 tick low

Of the options, revenue targeting (primarily to public transport) offers the best combination of lowest cost (compliance, administrative simplicity and enforcement) balanced against effectiveness (improving infrastructure and services), impact on travel behaviours and ease of understanding. The other options all have higher transactions costs, require a greater degree of understanding and encourage past behaviours and habits to be maintained. These other options also have cost impacts upon the revenue gained from the scheme.

10.4 Conclusions

Public transport improvement is seen by the focus groups as the most important initiative. This is reinforced by the literature on social acceptability and behavioural economics, which indicates that prior to scheme introduction, investment in PT is needed and that PT services need to be seen as reliable before behaviour change can be considered. The responses from the focus groups also suggested that the Congestion Scheme would encourage people to find employment closer to home and/or consider working from home. Therefore, strategically targeted walking and cycling investment around other urban centres may also assist with changing travel behaviours.

There are no significant barriers to other responses, such as carpooling and changing travel times, and up to half the focus group participants indicated that these responses would be options for them. Pricing would provide increased incentives in support of these responses. It would also be possible to implement exemptions and free days of travel using ‘tag and gantry’ technology, although the focus groups demonstrated a fairly uniform reluctance to recommend these options.

When these results are combined with the results of the PT analysis, it is reasonable to conclude that, for a vast majority of Aucklanders there would be reasonable options open to avoid paying the charge, and that specific exemptions to at-risk groups can be targeted.

11 Contribution to NZTS Targets

11.1 Introduction

The recently released *Sustainable Transport* discussion document contains a series of agreed and proposed targets to be included in the updated NZTS. The targets reflect the two key aspirations of the discussion document – to transform the economy and achieve environmental sustainability. An assessment was undertaken for each of the two schemes on the extent to which they would contribute to achievement of the targets set out in the *Sustainable Transport* document. Not all of the proposed targets were included in the assessment, because there are a number of targets for which road pricing is simply not relevant.

11.2 Summary of performance

The table below compares performance of the Congestion Scheme against the 2016 'no-pricing' environment. A negative performance is marked with a cross, and a positive performance a tick. A more detailed analysis is set out in the NZTS Workstream Report.

Target	'No-pricing' scenario	Congestion Scheme
Halve per capita greenhouse gas transport emissions	☒ CO_2 emissions expected to continue to increase. No contribution to target (in fact a worsening).	☑ CO_2 emissions continue to increase but at a slower rate than under 'no-pricing'. Significant contribution to target of about 26% to 30% of the desired target.
Travel times by all modes will be predictable	— Planned heavy investment keeps travel times approximately the same as currently.	☑ Improvement in speed/free-flow speed over the no-pricing scenario, and a reduction in the percentage of the network that is congested (from 20% to 13%), so we expect that travel times more predictable under the Congestion Scheme than without road pricing.
Travel times by principal routes to be improved relative to 2007 for identified critical intra- and inter-regional connections, as determined within each region	☒ Travel time between key economic centres is expected to increase, from an average of 15 minutes to 22 minutes in 2016.	☑ Travel times improve on the majority of key routes in comparison to the no-pricing scenario. The scheme also improves the times between key economic centres, and for car travel time to employment centres.
All individuals have access to the facilities and activities they need, such as work, education, medical care and shopping centres, to participate in society	— No improvement in number of households within 30 minutes of key economic centres in Auckland, but sector to sector travel times are expected to marginally decrease in most cases.	☑ Over a third more people are within 30 minutes by car of an employment centre over the 2001 base year data, and double the number of PT users. 12% increase over the no-pricing scenario for car and 45% for PT, and the total number of households within 30 minutes of key centres increases by approximately 10%.
Public health effects of transport to be at accepted international standard	☑ Predicted increase in active modes and move to cleaner, more efficient vehicle fleet is likely to contribute to the target.	☑ Even greater predicted increase in active modes and move to cleaner, more efficient vehicle fleet is likely to contribute strongly towards the achievement of the target.

Target	'No-pricing' scenario	Congestion Scheme
Local environmental impacts of transport (including air and water quality) to be at accepted international standard	— Expected decrease in air emissions over 2001 because of cleaner, more efficient vehicle fleet, but increase in run-off to sensitive catchments.	☑ Will result in a decrease in air emissions and a reduction in contaminants in runoff to sensitive receiving environments. Reasonably significant contribution to the target.
Reduce the kilometres travelled by single-occupancy vehicles in major urban areas on weekdays by 10% per capita by 2015 compared to 2007	☒ Trip numbers expected to continue to increase.	☑ Congestion Scheme is likely to reduce the number of single-occupancy trips far more than the no-pricing scenario – a total trip reduction of approximately 43,000. Likely to make a far greater contribution to this target than the no-pricing scenario.
Increase the public transport mode share of peak hour travel (journeys to work) in Auckland, Wellington and Christchurch from an average of 9% to 20% and work with each region to optimise peak hour travel targets	— No significant predicted increase in PT mode share (peak mode share expected to go from 10.5% in 2001 to 11.2% in 2016). Unlikely to contribute significantly to target.	☑ Expected PT mode share in peak across the entire network to be 15% of all trips. Journeys to work expected to have a mode share of about 18% across the region. Strong contribution to the target.
At least double the overall public transport mode share to 7% of all passenger trips (currently about 2-3%)	— No model output possible (only peak period modelled in this study) but given small peak period change, no significant contribution expected.	☑ No model output possible (only peak period modelled in this study) but given strong peak change, a reasonable contribution to the target is expected.
Increase walking and cycling and other 'active modes' to 30% of total trips in urban areas (currently about 17%)	— Only minimal mode share increase expected in peak period (from 14.4% to 15.6%), so no significant contribution to target expected.	☑ Peak period mode share increases from 14.4% to 18% (across whole Auckland network). In the charged area (central urban) share expected to be much higher, so a reasonable contribution to the target is expected.
Ensure a substantial reduction in premature deaths and serious illnesses arising from air pollution from motor vehicles	☑ Expected to be a contribution to the target as a cleaner, more efficient fleet is effective in reducing emissions as result of expected technology improvements.	☑ Expected to contribute strongly to achievement of the target. Modelling shows reductions of between 12 and 24% (compared to no-pricing) for NOx, PM10 and VOC.
Manage noise to minimise any public health effects	☑ Improvements to motorway networks are predicted to result in lower traffic volumes and therefore noise on selected arterial network. Will contribute to target.	☑ More reduction than no-pricing scenario (expected to be in the order of 5-6%), so even stronger contribution to the achievement of the target.

The table shows that the Congestion Scheme will be a strong contributor to a number of the proposed NZTS targets and, arguably, provides a means of getting closer to achieving some targets that the modelling shows will be very difficult to achieve in a non-priced environment. In general, road pricing can also provide a kick-start to public transport by encouraging motorists to shift modes, providing the impetus to improve the coverage and frequency of the PT network, which will be a key contributor to achieving some of the NZTS aims. Finally, road pricing also presents the opportunity to provide incentives to achieve other targets. An example would be to introduce a scheme, such as the London Congestion Charge which includes exemptions for electric or alternative fuel vehicles, and will this year introduce a 100% discount for vehicles that meet certain criteria on CO_2 emissions.

12 Technology

12.1 Introduction

The main purpose of the charging mechanisms assessment was to build on the work undertaken during ARPES, and to provide direction on the suitability of charging mechanisms and technology choices for the two schemes to assist the broader evaluation process.

12.2 Technology choice

The Congestion Scheme is an area scheme, which requires the capture of trips within the boundary as well as those that cross the boundary. Area schemes apply charges to trips made within a defined area during a defined time period. Users who wish to use (or keep) their vehicles within a defined area during a defined time period need to purchase and display a special permit, or to register the vehicle registration number in a computer database (eg the London Congestion Charging scheme). A key advantage of these pricing mechanisms is that for a small, simple scheme they can be relatively easy for the public to understand and relatively straightforward to implement.

In this context, from a 'fitness for purpose' perspective, the main requirements of the Congestion Scheme can be summarised as follows:

- Ability to monitor at least a proportion of internal traffic movements, in addition to those crossing the boundary.
- Operation of a relatively high number of boundary points with most of them located in urban street environments.
- Addressing of urban street and highway environments.
- Ability to identify qualifying exempt vehicles and provide for a range of account and special purpose concession schemes.
- Requirement to match and consolidate trips (for some categories in real time).
- Need for visible and credible compliance monitoring and appropriate penalties.
- Provision of charging mechanisms that meet public expectations of simplicity and fairness.

From these requirements, several technology options were evaluated. The first stage assessment of the technology options, measured against the broad requirements of the Congestion Scheme, eliminated both paper-based and manual charging as potential methods, concluding that these types of facilities would present difficulties of traffic disruption and limitations on future ability to vary charges by time of day and level of congestion. Global navigation satellite systems (GNSS) were identified as technically possible, but not cost-effective currently.

The conclusion of the first level assessment was that the only feasible options for implementation were a Dedicated Short Range Communications (Tag and Gantry) system (DSRC), Automated Numberplate Recognition (ANPR) or a combination system. The table below (Table 16) presents the results of this first evaluation.

Table 16: First level assessment of options for Congestion Scheme

Congestion Scheme	
Paper-based system	Not recommended due to cost of operations and the scale of enforcement that would be required.
Manual toll-plazas	Not applicable due to significant disruption to traffic.
ANPR	Potential option to be evaluated in greater detail.
DSRC	Potential option to be evaluated in greater detail.
Vehicle positioning GNSS systems (GPS, Galileo)	Technically possible, but not cost-effective currently.

A more detailed assessment was then undertaken against a series of additional criteria:

- Fitness for purpose
- Risks and mitigation
- Capital and operating costs
- Alignment with TSP
- Procurement issues
- Lessons from international review.

Based on the more detailed assessment, the recommendation for the Congestion Scheme was for a system using a DSRC tag based solution with an ANPR enforcement facility. A number of key factors influenced the decision:

- High proportions of regular users, and expected high take-up rates for DSRC payment, will increase the cost effectiveness of a DSRC solution and reduce overall operating costs.
- Expected reduction in future capital costs.
- Improved overall system reliability and accuracy, leading to higher net revenue.
- Improved convenience and security for users.
- Alignment with Transit's TSP solution for toll roads.
- Future flexibility and reliability.

The selection of a DSRC system for the Congestion Scheme provides a flexible and reliable system that can effectively charge all vehicles moving across the defined area. This type of system also offers the potential to provide more flexible charging variations, and an improved ability to differentiate vehicle types and functions. A DSRC system also provides improved opportunities to address exemptions by use of special status OBUs, and the use of OBUs reduces the enforcement task by efficiently processing payments from a large proportion of passing vehicles. OBU transactions linked to smartcard payments and accounts provide a high degree of reliability and ability to ensure payment, with significantly lower operating costs due to automated collection and enforcement.

These conclusions are consistent with, and confirm, the findings in the ARPES work, and are consistent with the development of an electronic tolling capability in the Toll Systems Project. Further detail on the comprehensive evaluation process undertaken, including consideration of operational systems around the world, and the bottom-up development of technology costs to be used in the financial analysis, are available in the Charging Mechanisms Report.

Part 3: Revenue Scheme

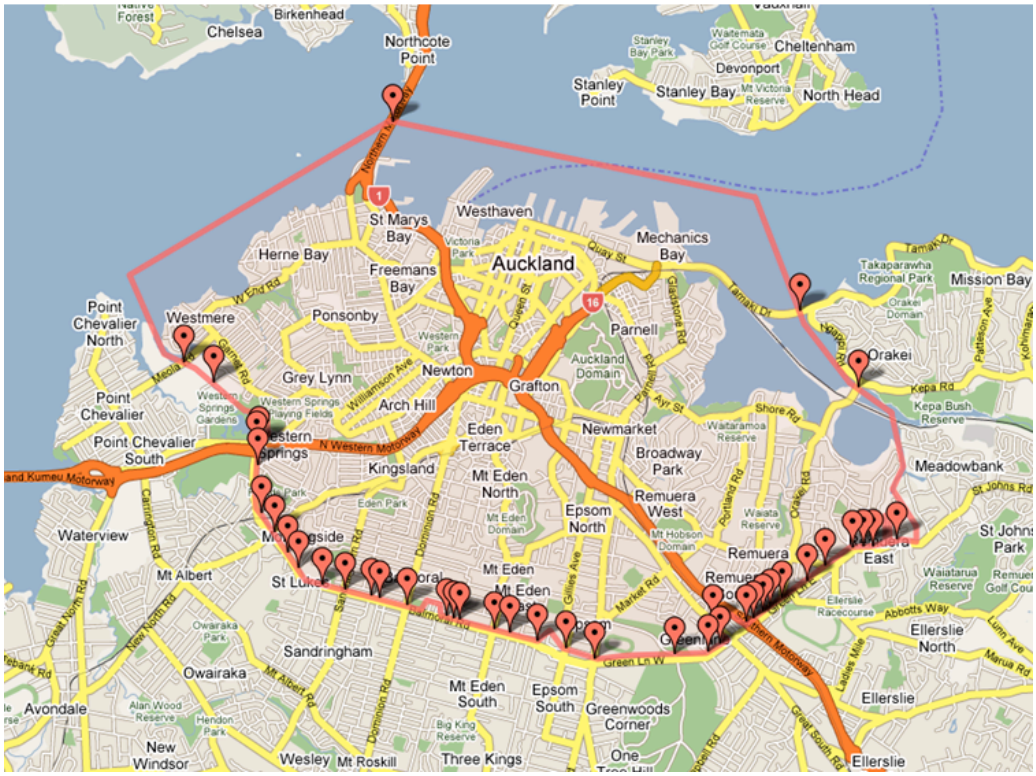
13 Objective of the Scheme

The Ministry's aim was to assess two different schemes that represented two very different approaches to pricing in Auckland: one with a clear focus on reducing peak hour congestion in Auckland and one focusing on collecting revenue towards the funding of required transport system improvements without making any significant social or economic impacts. Therefore, the primary objective behind the design of the Revenue Scheme for this Report was to generate revenue for transport-related projects by charging users directly for using all or part of the transport system, but at the same time try to minimise or avoid negative social or economic impacts.

There are obviously overlapping objectives compared with the Congestion Scheme, in that the imposition of a charge will have some congestion-reduction and mode-share benefits. However, the Revenue Scheme does not focus on peak period travel, and would charge all vehicles (cars, vans, trucks, motorbikes and taxis alike would pay the charge, while buses receive a 100% discount) entering or leaving the charged area at any time of the day or week in order to raise revenue. The charge level was set at $3 per trip with a maximum $3 charge per day (ie, one payment covers multiple entries and exits) in order to minimise social impacts.

The Revenue Scheme, as designed for this Report, is what is commonly referred to as a cordon scheme. This involves a charge when crossing the charging area boundary in both directions. The boundaries for the Revenue Scheme are based on the Area Scheme zone boundaries from the ARPES 2006 study (see Figure 17 below – note that the red markers represent charging points on the cordon). This is a small cordon tightly focused on the CBD.

Figure 17: Revenue Scheme boundaries



The findings from each of the workstreams in relation to the Revenue Scheme are set out in the following chapters.

14 Transportation Results

14.1 Introduction

The objectives of the transport demand modelling undertaken by the ARC for the Revenue Scheme were to show the transport (road traffic and public transport) impacts of the scheme as opposed to the non-pricing environment, and provide required inputs to the other workstreams.

14.2 Traffic modelling

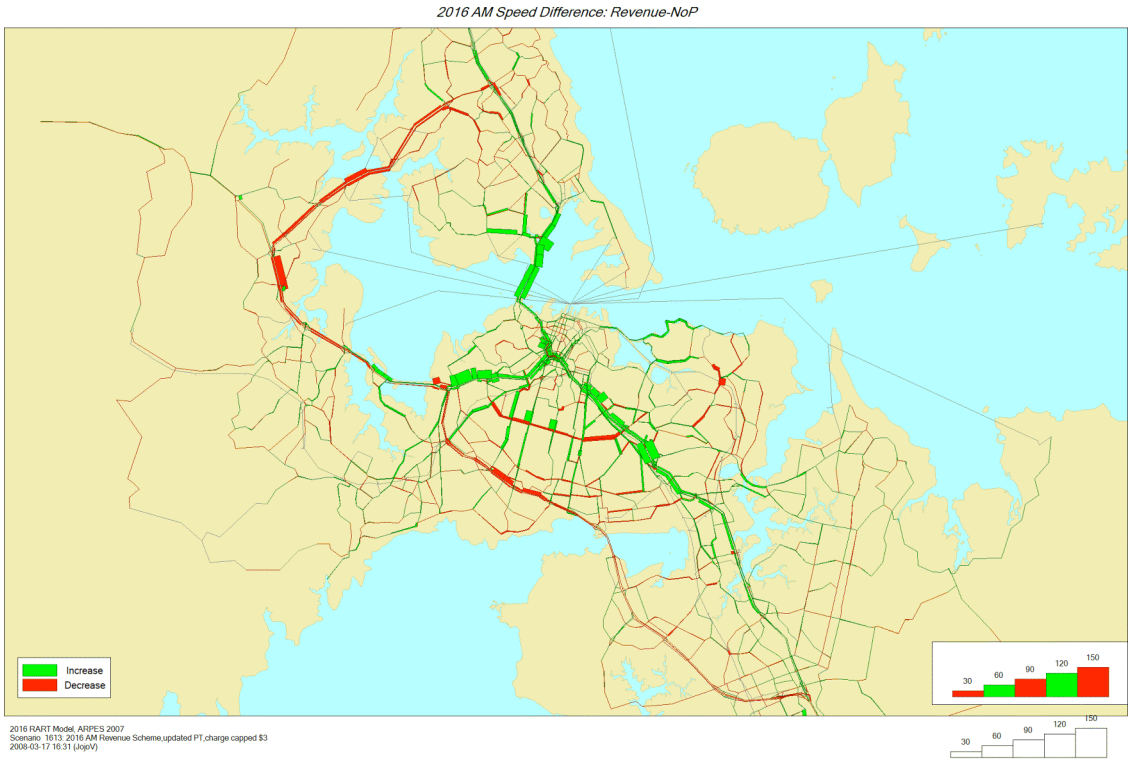
The results for the Revenue Scheme are shown below in Table 17.

Table 17: Transportation modelling results – Revenue Scheme

Item	Unit	2001	Base 2016	Revenue 2016
Traffic demand	vehicle trips	358,265	446,157	441,508
Total vehicle kms travelled	kms	3,679,294	4,538,148	4,378,735
PT mode share	% of total trips	10.5%	11.2	12.7
Mode share of walk and cycle	% of total trips	14.4%	15.6	15.9
Average trip length	km	10.3	10.2	9.9
Average network speed (all networks)	km/hr	38.8	39.6	41.5
Average network speed (isthmus)	km/hr	36.01	38.7	38.9
Average network speed (north)	km/hr	36.5	37.6	44.3
Average network speed (west)	km/hr	37.7	37.6	40.8
Average network speed (south)	km/hr	50.27	46.6	47.2
Average vehicle travel time	mins	15.9	15.4	14.4
Average PT pass travel time	mins	68.2	60.7	60.6
Car travel time to employment centres	mins	25	18.0	16.5
PT travel time to employment centres	mins	47	49.6	45.7
%age of VKT at LOS A/B	%	56.6	57.6	59.8
%age of VKT at LOS C/D	%	23.5	22.4	23.2
%age of VKT at LOS E/F	%	19.9	20.0	17.0

The network speed changes as a result of introducing the Revenue Scheme are shown below in Figure 18. The figure shows that, even with a relatively low charge of $3 and no ability to 're-time' out of the peak period, there are reasonable speed improvements through the central isthmus at peak times. The figure also demonstrates the need to consider management of diversion from the scheme charging zones (eg to use the Western Ring Route) in any detailed scheme-design process.

Figure 18: Network speed changes: Revenue Scheme vs 'no-pricing'



In summary, the traffic results for the Revenue Scheme show:

- slightly fewer trips are generated in the region, and total vehicle kilometres travelled during peak times reduce also. Both impacts are marginal, with reductions of approximately 1.5% – 3%
- public transport and walking and cycling mode shares increase, but not significantly
- all sectors reflect faster network speeds when charging is implemented. The strongest results are in the north sector, probably reflecting a combined effect of Harbour Bridge charging diverting trips, diversion to the Busway and speeding up the local network
- there is a slight improvement in public transport trip times due to reduced road trips resulting in higher road speeds and correspondingly higher public transport speeds. Public transport trip times to the key employment centres show a greater improvement than at the overall network level because of the domination of the CBD
- even with the relatively low charge, the associated vehicle trip reduction and re-distribution improves Level of Service (LOS) on roads in the region, with higher proportions of good LOS A/B and lower proportions of roads with poor LOS E/F.

Analysis has also been undertaken on the expected changes in times for some typical trips in the AM peak in 2016. Shown in the table on the next page, the analysis demonstrates that even the low charge of the Revenue Scheme can have significant benefits for some car trips.

Table 18: Specific trip time changes – Congestion Scheme

Car Trips	No Pricing 2016 (shortest trip)	Congestion Scheme 2016 (shortest trip)
Travel times, mins	Time, mins	Time, mins
Takapuna to Airport	46	34
Albany to CBD	37	25
Panmure to CBD	19	18
Mangere to CBD	25	23
Henderson to CBD	32	27
Henderson to Takapuna	33	34
Mt Wellington to Takapuna	29	27
Henderson to Mt Wellington	43	37
Ponsonby to Parnell	11	10

14.3 Public transport

The analysis undertaken did not focus specifically on passenger transport for the Revenue Scheme. The primary reason for this is that the Revenue Scheme was designed to have minimal or no social impact as illustrated in Table 17, which shows only small reductions in the number of trips taken and few shifts to public transport. Further, it is expected that the revenue collected would be likely to be spent, largely, on infrastructure and services that would improve passenger transport as an alternative to paying the charge. There is a reasonable expectation that any issues associated with the need to provide an alternative to paying the charge for certain trip types or to certain parts of the region could be addressed. Finally, as shown in section 5.3, the analysis undertaken in this study shows that the Passenger Transport Network Plan network structure would be robust if the Congestion Scheme was implemented, and that while localised PT improvements would be required to provide a real alternative to paying the charge, these are essentially marginal service-level improvements.

15 Household Impacts

15.1 Introduction

In 2016, under a 'no-pricing' (base case) scenario, it is estimated that a total of 3.628 million trips will be generated by households in the Auckland Region during an average day (including weekdays and weekends) – an average of 7 trips per household. The largest share of these trips will be undertaken in a private vehicle as either a driver (62.7%) or a passenger (11.8%). The remaining trips will be undertaken using public transport (8.6%) or walking or cycling (16.9%). Approximately one in five trips (20.3%) are car-driver, work-commuting trips. Under the Revenue Scheme, overall there is very limited change in the total number of trips undertaken for each purpose of travel.

There is also limited modal shift from the 'no-pricing' scenario. Car-driver trips decrease by 0.3% (-7,200 trips) and car-passenger trips by 1.7% (-7,300 trips). At the same time, public-transport trips increase by 5.9% (+18,000 trips) and walk and cycle trips increase by 0.8% (+4,700 trips). The major share of the decrease in car-driver trips is among work commuters with a drop of 8,400 car-driver, home-work-home trips, a decline of 1.1%. There are small decreases indicated in the other and education trips, but an overall increase in serve passenger trips.

The change in travel is small, indicating that the Revenue Scheme would have quite minor effects on overall household travel patterns – the purposes of travel, or timing or mode.

15.2 Nature of directly impacted trips

Trips may be directly impacted by the Revenue Scheme in one of three main ways:

- A trip may be undertaken using a different mode to avoid being charged.
- A trip may be not undertaken, or taken at a different time, to avoid the charge.
- A trip may be undertaken in the same manner as usual, but be subject to a charge.

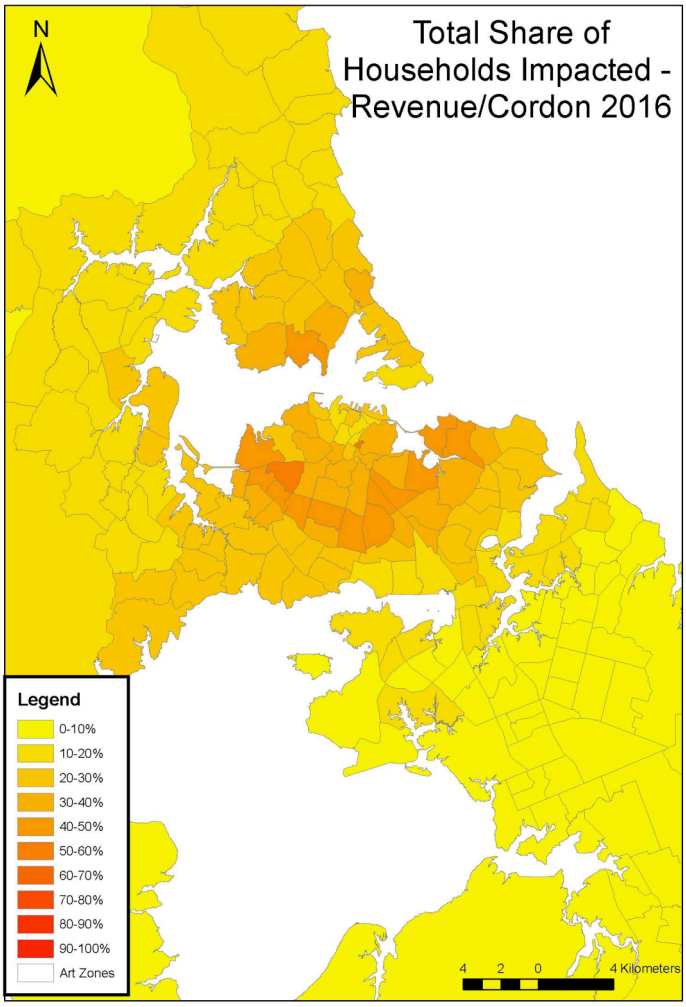
In 2016, it is estimated that a total of 116,900 trips, or 3.2% of all trips would be impacted by the Revenue Scheme. The largest share of these trips (73%) will be impacted by incurring the charge, while the other quarter (27%) are impacted by changing mode or trip suppression (ie changing behaviour). Overall, some 84,800 household trips (2.3% of total trips) will incur the charge. Some 32,100 trips will be impacted as households change their behaviour to avoid the Revenue Scheme charge. Most behaviour change will occur by changing mode from car driver or car passenger to either public transport or walk or cycle (23,300 trips or 0.6% of trips).

By purpose, home-work-home trips are the most heavily impacted by the Revenue Scheme. These trips account for 85% or 99,000 of the total of 116,900 impacted trips, including 79% of trips where behaviour changes to avoid the charge, and 87% of trips which are charged. The Revenue Scheme has a limited impact on trip-making behaviour, indicated by most (73%) opting to incur the charge rather than change behaviour. This means that the scheme is likely to have little deterrent effect in shifting trips from private vehicles to other modes, consistent with its main role of raising revenue, without significant impacts, rather than avoiding congestion. The impact is heaviest on commuting trips, with 10% of home-work-home trips impacted, but even then the traveller preference is to incur the charge rather than change mode, given that the charge is set low.

15.3 Households impacted

In 2016, it is estimated that 20-23% of households will be directly impacted by the Revenue Scheme by either incurring the charge (14-16%, or between 74,600 and 84,800 households) or changing their behaviour to avoid the charge (5-6%, or between 27,500 and 33,300 households). The proportion of households impacted (20-23%) is greater than the proportion of trips impacted by the Revenue Scheme (3.2%). This is because households typically make multiple trips in the course of the day, while only the first of such trips crossing the Revenue Scheme cordon will incur the charge. Overall, the low impacts are spread across households, with only a few household types indicating a significantly lower level of impact. These include older-single-person households (only 4% are impacted) and older-couple households (only 10% are impacted). Both of these have low journey-to-work travel (most adults are retired) and generally lower-than-average trip rates for other purposes. Among the other types of household, the impact rates are mostly reasonably close to the overall average of 20%, with 18-22% of households impacted. Figure 19 below illustrates the geographical distribution of households impacted by incurring the charge or changing behaviour to avoid the charge.

Figure 19: Share of households impacted – Revenue Scheme



The dominant feature in Figure 19 is the arc following the scheme boundary and skirting the Auckland CBD, from Point Chevalier in the west through to Orakei and Mission Bay in the east. Across this arc, over 40% of households are impacted. In the areas to the north, impact levels are in the 30-40% range, with generally more households impacted to the north of the Revenue Scheme cordon than to the south. Nonetheless, throughout the remainder of the isthmus, and the eastern suburbs of Waitakere City, some 20-30% of households are impacted in one way or another. A similar incidence is evident in the central suburbs of North Shore City, from the southern East Coast Bays across to Glenfield. Across the remainder of Waitakere City and North Shore, as well as the Pakuranga-Eastern Beach area, impacts are generally uniform with 10-20% of households affected. As previously, across most of the rest of the urban area in Manukau City and Papakura District, impact levels are low, with 0-10% of households affected.

15.4 Financial impacts on households

Financial impacts on households for the Revenue Scheme have been considered as out-of-pocket costs and utility costs. Overall, it is estimated that the 'no-pricing' cost of travel for households that will be impacted by the Revenue Scheme is about 80% higher ($8,841 per household per annum) than for households that will not be impacted by the scheme ($4,913 per household per annum). There are two reasons for the differences:

- Car driver trips that cross the scheme cordon under the 'no-pricing' scenario (ie potentially impacted trips) are longer on average (14.2km) than trips that do not cross the scheme cordon (8.4km) and therefore incur higher vehicle-operating and time costs.
- Car driver trips that cross the scheme cordon under the 'no-pricing' scenario are significantly more likely to incur parking costs which are applied only to trips terminating in the CBD and Newmarket areas. It is estimated that impacted households incur 75% of all parking costs (an average cost of $419 per annum) while non-impacted households incur an annual average parking cost of only $34 (in the 7-9am period), largely from parking charges in suburban centres.

As a result of these factors, the estimated annual average out-of-pocket costs for impacted households (those making potentially impacted trips) under the 'no-pricing' scenario is approximately 2.4 times higher ($3,100) than for non-impacted households ($1,298). Similarly, estimated annual average time costs for impacted households ($5,741) are also higher than for non-impacted households ($3,615) under the 'no-pricing' scenario.

Table 19 on the next page shows that, for households impacted by incurring the Revenue Scheme charge, it is estimated that the additional annual average out-of-pocket cost will be $1,024, or approximately $3.40 per day – consistent with each impacted household incurring an average of $0.85 in charges per day (including weekends). This will amount to a 33% increase in out-of-pocket costs. At the same time, these households will make an annual average time saving of $108 as a result of travelling on a slightly freer network, and will also accrue a small additional benefit from additional trips undertaken ($12 per annum). In total, it is estimated that these households will incur additional costs of $904 per annum – a 10% increase over total 'no-pricing' travel costs.

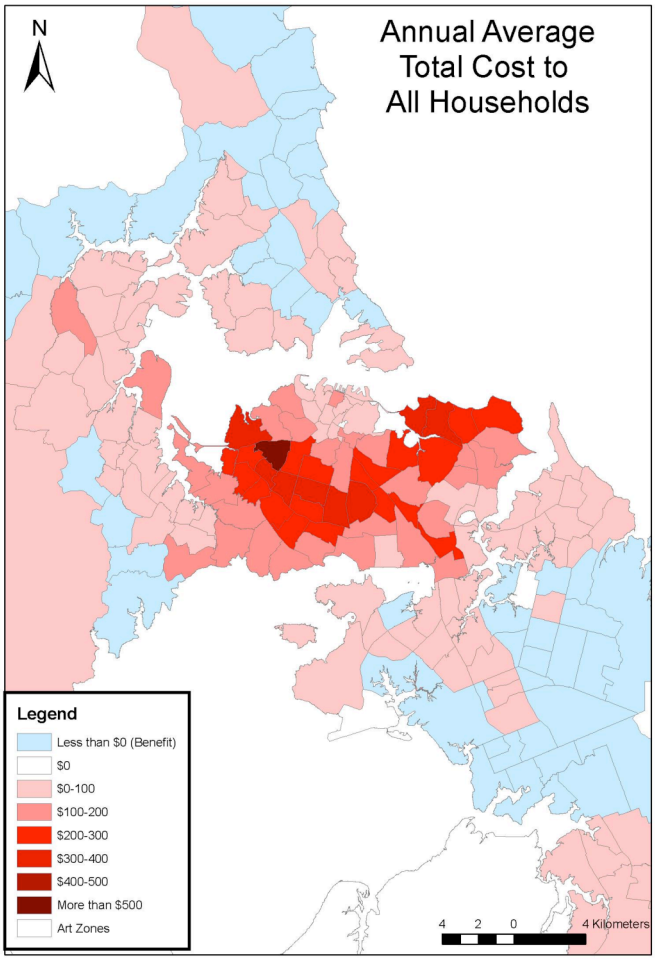
For households impacted by changing behaviour (switching from car to public transport or walk or cycle), out-of-pocket savings are made through reduced vehicle-operating costs (-$253 per annum) and reduced parking costs (-$118 per annum). However, additional public transport fares are incurred ($706 per annum), resulting in an overall increase in out-of-pocket costs of $335 per annum (11% increase). The greatest cost to those choosing to change behaviour is an increased time cost ($1,239 per annum) due to the switch from private vehicle to slower modes. Overall, those choosing to change their behaviour incur an 18% increase over total 'no-pricing' costs, from $8,841 per household per annum to $10,403 per annum.

Table 19: Financial impacts of revenue scheme on impacted households, 2016

IMPACTED HOUSEHOLDS							
	No Pricing	Revenue 2016					
		Impacted by incurring Charge			Impacted by Changing Behaviour		
	Annual average cost per Household of All Travel	Additional Annual Average Cost per Household of All Travel	Total Annual Average cost per Household of All Travel	% Increase in Costs from No Pricing	Additional Annual Average Cost per Household of All Travel	Total Annual Average Cost per Household of All Travel	% Increase in Costs from No Pricing
Out of Pocket Costs							
Scheme Charge	$ -	$ 1,024	$ 1,024	na	$ -	$ -	na
Vehicle Operating Costs	$ 1,657	$ -	$ 1,657	0%	-$253	$ 1,405	-15%
Public Transport Fare	$ 1,023	$ -	$ 1,023	0%	$ 706	$1,729	69%
Parking Costs	$419	$ -	$ 419	0%	-$118	$301	-28%
Total Out of Pocket	**$3,100**	**$1,024**	**$4,124**	**33%**	**$335**	**$3,435**	**11%**
Utility Costs							
Value of Time	$5,741	-$108	$5,633	-2%	$1,239	$6,980	22%
Value of Trips Not Made	$ -	-$12	-$12	na	-$12	-$12	na
Total Utility	**$5,741**	**-$120**	**$5,621**	**-2%**	**$1,227**	**$6,968**	**21%**
Total Cost	**$8,841**	**$904**	**$9,745**	**10%**	**$1,562**	**$10,403**	**18%**
Total Cost (All Households) ($m)	**$903**	**$67**	**$727**	**16%**	**$43**	**$286**	**27%**

15.4.1 Spatial distribution of financial impacts to all households

Figure 20: Total annual average costs to all households, 2016



Combined out-of-pocket and time cost effects are shown in Figure 20. The arc of impact extends across the Auckland isthmus from west to east. Households in the vicinity of the Revenue Scheme boundary, as expected, show the highest level of impact, with average out-of-pocket and time impacts in the $200-400 per household per annum range. Across most of the remainder of Auckland City, the impacts lie in the $100-$200 per household per annum range.

Elsewhere, the pattern varies. Most of Waitakere City shows an average cost of $0-$100 per-household-per-annum, as does the Howick-Pakuranga area, and Mangere-Wiri in Manukau City, and parts of the North Shore. However, much of the rest of Manukau City, as well as the central and northern North Shore, and the Titirangi-Oratia area all show a small net benefit when out-of-pocket and time costs are combined.

15.4.2 Impacts of out-of-pocket costs

The financial impacts of a scheme are of most concern when the out-of-pocket impacts are relatively high and households' ability to pay is low.

There are two areas in the region where relatively high levels of deprivation coincide with relatively high out-of-pocket costs under the Revenue Scheme – Rosebank-Waterview, and Wesley-Akarana. Rosebank is predominantly light industrial, though there are lower income suburbs in the south of the peninsula. Waterview and Wesley are both predominantly residential and recognised as lower socio-economic areas within Auckland City. A larger general area covering the central western area of the Auckland isthmus is of next greatest concern, subject to either high deprivation and medium impact or medium deprivation and high impact. These are the areas on which mitigation measures would need to focus if a decision was made to proceed.

Out-of-pocket costs can also be contextualised by considering additional out-of-pocket costs as the result of a scheme in relation to household income. Overall, additional out-of-pocket costs resulting from the Revenue Scheme would amount to 1.7% of the average household income (of all households in the region).

Table 20: Distribution of out-of-pocket cost impacts (as a share of household Income)

Revenue 2016	**Number**	**% All H'holds**	**% Impacted H'holds**
Very Low Impact (0-1% of H'hold Inc)	-	0.0%	0.0%
Low Impact (1-2% of H'hold Inc)	53,000	10.3%	52.2%
Medium Low Impact (2-3% of H'hold Inc)	7,800	1.5%	7.6%
Medium Impact (3-4% of H'hold Inc)	6,000	1.2%	5.9%
Medium High Impact (4-5% of H'hold Inc)	29,300	5.6%	28.7%
High Impact (5+% of H'hold Inc)	5,700	1.1%	5.6%
Total Impacted H'holds	102,100	19.7%	100.0%
Total Not Impacted H'holds	417,000	80.3%	na
Total	**519,000**	**100.0%**	**na**

Table 20 shows that for 90.6% of all households (about 52% of impacted households), the additional out-of-pocket impact of the Revenue Scheme is either nil, very low or low (2% or less of net household income). About 2.7% of all households (13% of impacted households) incur an additional out-of-pocket impact in the range of 3-4% of net household income. However, approximately 5.6% of all households, and about 28% of impacted households, would incur an additional out-of-pocket impact in excess of 5% of net household income.

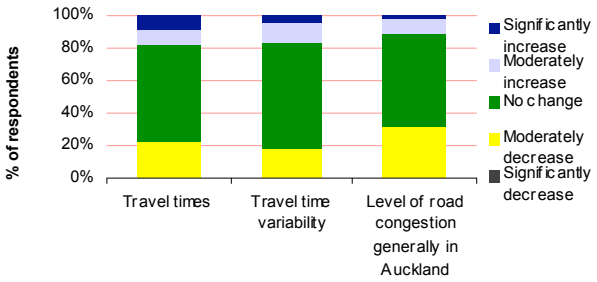
16 Economic Impacts

16.1 Introduction and approach

As noted in section 7.1 the economic impacts workstream featured consultation with firms and industry associations representing businesses in Auckland. Specific findings in relation to the Revenue Scheme are discussed below.

16.2 Road carriers

Figure 21: Impacts of the Revenue Scheme



General

Only a minority of road carriers thought that the Revenue Scheme might have a moderate impact on the reduction of travel times, travel time variability and overall congestion (Figure 21). Most road carriers considered that a $3 charge would have little or no impact on congestion and therefore little impact on operating costs such as fuel and RUC.

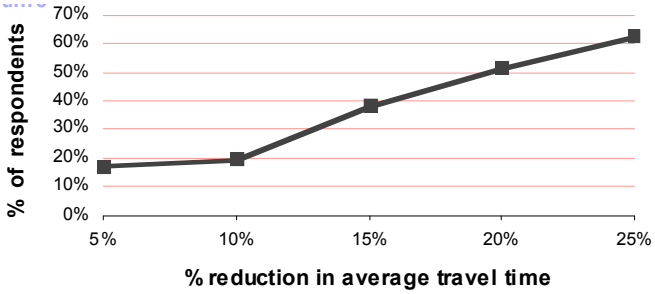
Labour market

In response to the Revenue Scheme resulting in a hypothetical 10% reduction in trip times, about half of the respondents (51%) indicated that they would expect employment costs to fall and operating hours to reduce. Some respondents (28%) thought it would be easier to attract and retain employees and but many (63%) thought that the Revenue Scheme would have no impact on the ability to attract or retain employees.

Business location

The Revenue Scheme was considered to have little bearing on business location. Only one respondent thought that a 10% reduction in trip time might influence location.

Figure 22: Willingness to pay $3 for reduction in travel time



Productivity

The survey asked road carriers about their willingness to pay to achieve a reduction in trip times, on the assumption that if travel time savings translate into productivity improvements, road carriers would be willing to pay something to achieve this outcome. The graph (figure 22) shows the response given to a $3 charge.

Nearly a quarter (23%) of respondents indicated the Revenue Scheme, with a 10% reduction in trip time, would cause them to reduce their vehicle fleet and 11% indicated they would increase their fleet. The reasoning behind this seems to be that reduced congestion could lead to a growth in business activity. Just over half (54%) of respondents indicated that the frequency of deliveries would increase.

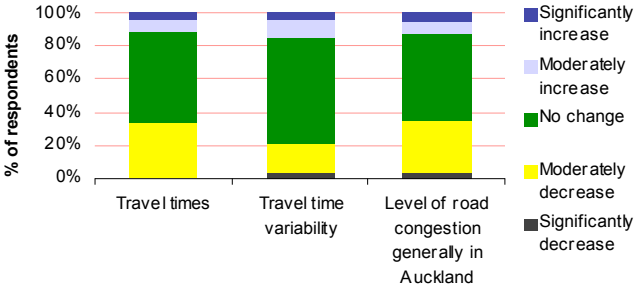
Profitability

Responses to the Revenue Scheme, with a hypothetical 10% reduction in trip times, point to some improvement in profitability as a result of:

- lower fuels costs (66% of respondents) which account for about 20% of expenditure
- reduced other operating costs (42% of respondents) which account for about 15% of expenditure
- lower labour costs (51% of respondents) which account for about 25% of expenditure.

16.3 Retailers

Figure 23: Perceived impacts of the Revenue Scheme

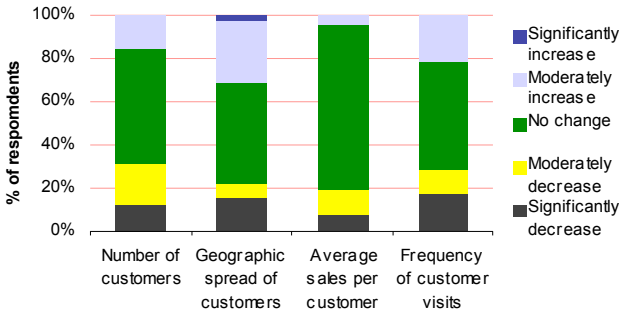


General

Like road carriers, retailers were not convinced that the Revenue Scheme would reduce congestion. A minority thought that the Revenue Scheme might have an impact on a reduction in travel times (34%), travel time variability (21%) and overall congestion (36%) (Figure 23).

Somewhat curiously, a small number of respondents thought that the Revenue Scheme might actually increase congestion (12%), travel times (11%) and travel time variability (15%). It may be that responses reflect general expectations that congestion is a growing problem or that a scheme will only move congestion from one place to another.

Figure 24: Perceived impacts of Revenue Scheme with 10% reduction in trip time



Customers and revenue

There was little expectation that the Revenue Scheme would make it easier for customers to shop within the zone. Conversely, some felt the Revenue Scheme would deter shoppers from entering the zone.

Most retailer respondents (66%) felt that the Revenue Scheme would have no impact on turnover, although 11% thought it would increase turnover and 23% thought it would reduce turnover.

For retailers targeting customers whose incomes are thought to be over $70,000, a Revenue Scheme cost of $3 per day or possibly $700-800 annually, was not considered to be a significant impost. In this case, any traffic congestion reduction effects would be positive for customers in that it would create a more pleasing environment to shop in, as well as a faster journey to the shopping area. This would be true for both higher-income CBD workers and the high-income demographic targeted by the Newmarket retail precinct.

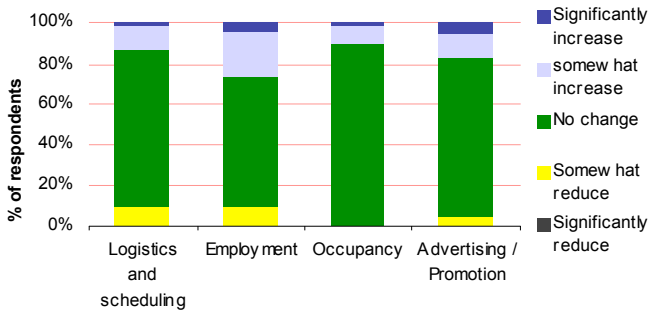
Overall, it appears that retailers consider the impacts will be slightly negative but that there will be winners and losers. In particular:

- more retailers thought a Revenue Scheme would reduce rather than increase the number of customers for them (32% reduce vs 15% increase)
- 19% thought it likely that the average sales per customer would reduce
- there was a fairly even split between retailers who thought that the frequency of customer visits would reduce (29%) or increase (21%)

Note that the results are by number of retailers and not weighted by the size of their revenues.

Operating costs

Figure 25: Perceived impact of scheme on operating costs



The majority of respondents do not expect any changes in operating costs as a result of the Revenue Scheme. Of the rest, more retailers expect costs to increase rather than decrease. This is likely to reflect the expectation that suppliers will attempt to pass on the costs of the Revenue Scheme through price increases (Figure 25).

Labour market

Most retailers (64%) expect no change to employment costs. Of the rest, the expectation is for an increase in employment costs (26%). More retailers thought that it would be harder (28%) rather than easier (21%) to attract and retain employees.

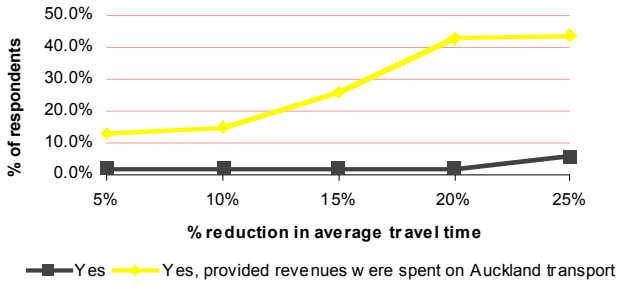
Business location

Fewer retailers considered that there would be a need to open new branches with a Revenue Scheme (25%) than in a do-nothing scenario with increasing congestion (42%).

Productivity

The Revenue Scheme appears to have a positive impact on productivity. More retailers indicated that they would not have an increase in operating hours with the Revenue Scheme (84%) compared to the proportion that indicated the same response in relation to existing congestion impacts (53%). Similarly, more retailers indicated that the need to support local retail area promotion would decrease (54% versus 73%) and to improve the retail attractiveness through store refurbishments would decrease (31% versus 65%) with a Revenue Scheme in place.

Figure 26: Willingness to pay $3 for reduction in travel time



The survey asked retailers about their willingness to pay to achieve a reduction in trip times, on the assumption that if travel time savings translate into productivity improvements, retailers would be willing to pay something to achieve this outcome. The graph (Figure 26) shows the response to a $3 charge.

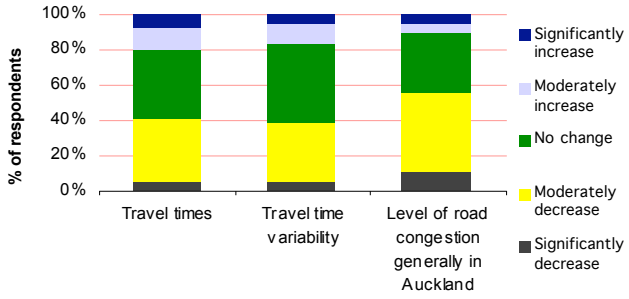
Revenue hypothecation (dedication) expectations significantly impact on these results. In the absence of these, few retailers are willing to pay.

Profitability

The Revenue Scheme is not expected to have significant impacts either way on the profitability of the majority of retailers.

16.4 Other businesses

Figure 27: Perceived impact of the Revenue Scheme



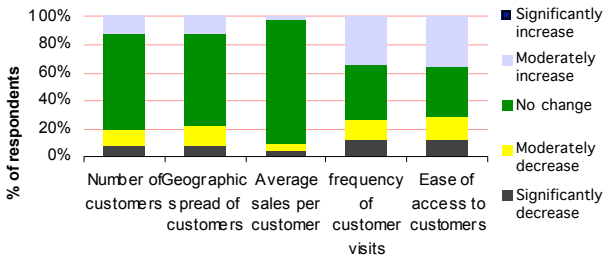
General

Compared to the responses received from the retailers and road carriers, other businesses were generally more optimistic about the degree to which the Revenue Scheme would assist in alleviating congestion (Figure 27).

Most notable among the responses is that a majority (56%) consider that the Revenue Scheme would reduce congestion generally in Auckland. In contrast, only 31% of road carriers and 36% of retailers consider that the Revenue Scheme would reduce congestion.

Customers and turnover

Figure 28: Perceived impact of Revenue Scheme



There also appears to be an expectation that the charge zone will deter some customers from entering the zone, with a consequent expectation, for 21% of respondents, of a reduction in the geographic base from which customers are drawn. The results from the survey are illustrated in Figure 28.

For the majority (64%) of respondents, the Revenue Scheme was not expected to have any impact on turnover. Slightly more businesses (21%) indicated that the Revenue Scheme would reduce turnover than increase it (14%). The likely reason behind this is the expectation that some journeys will be diverted to other parts of Auckland (to avoid the $3 charge) and, consequently, some business will be lost.

Despite this, slightly more respondents thought that ease of access to customers would be improved (36%) rather than worsened (29%).

Labour markets

In general, a $3 charge was not considered to be a major impediment to attracting employees. There was, however, some expectation that the charge would be discussed in the context of wage negotiations. The survey results back this up to some extent, with 29% considering that employment costs would rise with the Revenue Scheme in place. Overall, however, more respondents (36%) thought that reduced travel times would make it easier to attract employees, rather than harder (26%).

Business location

Nearly a third of business survey respondents considered that the Revenue Scheme (and by implication, less traffic congestion) would improve the general amenity of their business's location. A somewhat lower proportion (21%) thought the general amenity would deteriorate.

Interestingly, 29% indicated with a Revenue Scheme in place, they would be more likely to relocate to somewhere with better public transport access, 33% closer to a motorway, and 19% closer to their workforce.

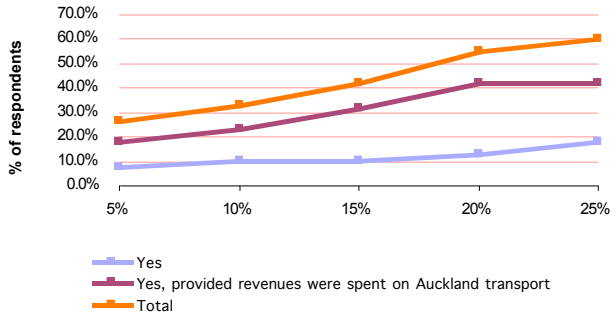
Productivity

Overall, the balance of winners and losers in relation to employee costs and ease of retention, access to customers and impact on turnover, appears relatively neutral (or possibly a very mild negative impact).

Profitability

The survey results also paint a mixed picture in terms of impact on profitability. Overall, the survey responses point to a slight net adverse impact on profitability given that a slightly higher proportion of respondents anticipate a reduction in turnover (21%) than those who expect an increase (14%), significantly more respondents expect employment costs to increase (29%) than decrease (10%) and significantly more respondents expect occupancy costs to increase (12%) than reduce (2%).

Figure 29: Willingness to pay for reduction in trip time



Businesses were asked to indicate whether or not they would be prepared to support the Revenue Scheme's $3 charge if it led to reductions in average travel time. The results are illustrated in Figure 29.

Again, revenue hypothecation expectations are important but overall, businesses appear to be slightly more willing to pay than are retailers.

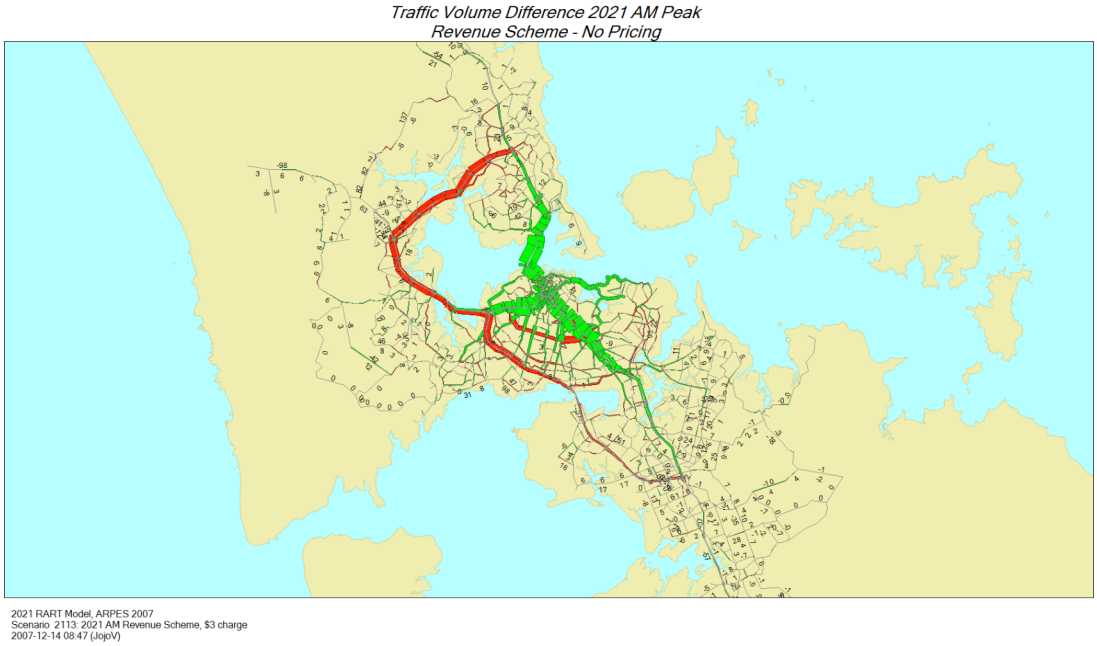
17 Environmental and Land-Use Considerations

17.1 Amenity, severance and noise impacts assessment

The Revenue Scheme would decrease traffic volumes at 2016 and 2021 inside the scheme boundaries. Note that the volumes decrease from 2001 volumes without road pricing inside this area, reflecting significant improvements to public transport and traffic-demand management in 2016, particularly for trips to the CBD area. However, further reductions in traffic volumes of about 10% are possible under the Revenue Scheme on the selected links in the central urban area, further improving the amenity values of the central urban environment.

As shown in Figure 30, traffic volumes will increase above the 'no-pricing' scenario along the scheme boundaries and along State Highways 20 and 16/18. The diversion of traffic around the scheme boundaries, causing the increased volumes, is predicted to be generally confined to the main motorway network, and the St Lukes to Greenlane Road corridor.

Figure 30: Changes to traffic volumes on selected arterial links – Revenue Scheme



While the St Lukes to Greenlane corridor is already a busy road with severance and amenity effects, the scheme will increase these effects. Mitigation of the severance and amenity impacts would need to be considered. This may involve additional pedestrian crossings of the corridor in relevant areas, traffic management (speeds, turning movements) and enhanced pedestrian amenities, such as wider footpaths, solid medians and enhanced streetscapes. Conversely, on the arterial links, where there will be some reduction in future traffic pressures, the opportunity should be taken to lessen existing severance issues and to enhance the quality of the road corridor as a public space.

17.2 Stormwater quality impacts assessment

As for the Congestion Scheme, the assessment for the Revenue Scheme focuses on the benefits or adverse effects of changes in traffic volumes, on sensitive estuarine environments. Considering the likely impact of the schemes on contaminant loads entering the identified sensitive catchments, the table below sets out the percentage change in VKT by selected catchments under the Revenue Scheme.

Table 21: VKT for catchments with sensitive marine environments – Revenue Scheme

Selected runs	% Reduction (compared to 'no-pricing' scenario) in VKT for catchments with sensitive marine receiving environments	
	2016	2021
Okura	2.51%	1.45%
Upper Waitemata	-2.94%	-2.62%
Shoal Bay	2.45%	2.25%
Henderson	-5.13%	-4.56%
Whau, Waterview	-2.33%	-2.21%
Hobson	16.29%	15.58%
Mangere	3.05%	2.52%
Tamaki	1.86%	1.55%
Pukaki	-2.57%	-3.20%
Meola/Motions	22.79%	21.02%

Note: Positive %s are reductions in VKT from the "no-pricing" scenario and negative %s (in red) are increases in VKT

As expected, the Revenue Scheme results in significant reductions in contaminant loads in the central isthmus catchments inside the road-pricing area (Hobson Bay and Meola/Motions catchments). However, these benefits are offset by small increases in VKT in other sensitive catchments – the Upper Waitemata Harbour, Henderson, Whau/-Waterview and Pukaki catchments. This appears to be the result of north-south traffic diverting around the isthmus area.

The effects of these increases in contaminant loads on outer catchments could be mitigated by additional stormwater-quality treatment of road run-off in the affected areas, and thus overall enhancement of the sensitive catchments, under the road-pricing schemes.

17.3 Air quality impacts assessment

As with the Congestion Scheme, to assess the impacts of road pricing on air quality, the likely vehicle-to-air emissions have been estimated, based on RART-modelled traffic flows, for five urban sectors within the region, and for the region as a whole. Table 22 summarises the modelling results for region-wide air emissions under the Revenue Scheme, for the three parameters NOx, PM10 and VOC.

Table 22: Vehicle-related emissions to regional air shed – Revenue Scheme

Emissions to regional air shed (% reductions against 'No Pricing')	Revenue Scheme	
	2016	2021
NOx (kg)	4.3%	3.6%
PM10 (kg)	6.7%	5.8%
VOC (kg)	10.8%	9.3%

Although air emissions are predicted to decrease from 2001 levels by 2016 and 2021 even without road pricing, the Revenue Scheme may result in further reductions in emissions, particularly inside the charging area. The following key points can be noted:

- The reductions in air emissions under the Revenue Scheme compared to the 'no-pricing' scenario are relatively low, suggesting that the 24-hour charging basis may result in drivers being less likely to avoid travelling during peak times.
- The Revenue Scheme will particularly benefit the inner isthmus area. The central area will have relatively high pedestrian levels and an increasing number of high-density residences (apartments) and, on this basis, the reductions in air emissions in the central area are likely to have particular benefits.
- These benefits are offset by increases in emissions in the west Auckland urban areas, which would effectively negate a proportion of the reduction in NOx and PM10 emissions resulting from more effective fuel and emission standards. As seen in the modelled traffic volumes, this is likely to be due to north-south traffic diverting around the isthmus area into the west Auckland area, with traffic remaining on the motorway and main arterial road network, but tending to slow vehicle speeds and therefore increasing air emissions in the western sector.

17.4 Greenhouse gas emissions assessment

To assess the impact of the schemes on greenhouse gas emissions, the average quantity of CO_2 emitted during the AM peak, per vehicle kilometre travelled, was modelled for 2016 and 2021. The figures were then related to an estimate of CO_2 production in 1991 (which is one year different from the benchmark for Kyoto Protocol commitments of 1990). The modelled estimates were also considered in the context of the proposed updated New Zealand Transport Strategy target to halve the per capita greenhouse gas transport emissions by 2040, relative to 2007 emissions. To achieve this target, it was determined that, based on estimated Auckland population figures for 2040, by that year the per capita carbon dioxide emissions from Auckland traffic would have to be reduced to levels which are similar to 1991 levels.

Table below sets out an estimate of CO_2 production for the peak 7-9am period in 1991. The data is expressed as a percentage increase over 1991 levels.

Table 23 shows that the Revenue Scheme results in increased production when compared with 1991, although at a lower rate than under the 'no-pricing' scenario. Based on the 2016 and 2021 model results, the 'peak-period' carbon dioxide emissions without road pricing would be about 48-55% higher than 1991 levels. The Revenue Scheme will provide some buffering of this increase; the reduction provided by the Revenue Scheme from the 'no-pricing' scenario is about 8-10% of the 48-55% increase above higher levels.

Table 23 : Estimated changes in CO_2 emissions 1991–2016 and 1991–2021

Production (kg 000s)	1991	2001	No Pricing	Revenue
Estimated 2016 production (kg 000s)	1,024	1,227	1,513	1,461
% increase over 1991			47.8%	42.6%
Estimated 2021 production (kg 000s)			1,590	1,542
% increase over 1991			55.3%	50.6%

While the Revenue Scheme would not in itself meet the regional transport emissions target (ie reverse the total increases in carbon dioxide levels predicted with no road pricing), it would contribute about 8-10% of the reduction needed to meet the target.
The Revenue Scheme would therefore have to be considered as only one of a number of several initiatives instigated or planned to meet the UNZTS target.

17.5 Land use

The main focus of the analysis was to consider whether the schemes will assist with, or detract from, the agreed regional land use strategies, and/or whether longer-term land-use changes will undermine the benefits of the schemes. The table below sets out the key points of the analysis undertaken on the land-use implications of the Revenue Scheme.

Table 24: Land-use implications of the Revenue Scheme

Growth of RGS centres	The Revenue Scheme has only a modest impact on vehicle costs, with slightly larger benefit for public transport users, but the figures suggest no significant difference in transport's influence on the desirability of the Regional Growth Strategy centres as a business or residential locations, at a regional level.
Business development	Overall, the Revenue Scheme should assist slightly with a higher-quality environment for business activities within the core CBD / Newmarket areas, strengthening the agglomeration process, provided that public transport services are improved. This is an outcome consistent with regional strategies. However, the Revenue Scheme may not lift central area growth rates by any appreciable effect. It appears to support existing trends as, in general, the scheme has only a modest impact on relative accessibility into central areas. For other business areas on the fringes of the CBD, but within the charged area, the scheme may be a disadvantage, particularly for retail, manufacturing and distribution activities that rely on customers from inside and outside the charged area for their viability. For businesses in these areas there may be some pressure in the future to relocate to outer isthmus business areas.
Residential development	The scheme may contribute to a small upward demand for housing within the cordon area, particularly in areas with good public transport accessibility. However, this is likely to be minor given the modest nature of the charge. The removal of some retail and related services out of the charged area may free up land to accommodate this additional housing. Any transference effect of households moving into the cordon to avoid paying it is likely to be lessened by the house price differential that applies to housing inside the cordon compared to outside the cordon.
Corridor development	The scheme has only a minor impact on congestion levels on the arterial roads inside the cordon, with some small benefits in environmental quality. Outside the charged area, traffic volumes on east-west arterial roads generally increase, indicating a less desirable place for residential development and greater conflicts over access to non-residential activities.

Overall, the improvement to the quality of the environment within the charged area and the increased use of passenger transport is consistent with goals associated with the Auckland Sustainability Framework. In fringe CBD areas, off the main public transport routes where retail and service-related activities are more dominant, some relocation of activities out of the charged area can be expected, with land converted to residential use. This may be consistent with regional strategies, provided that the displaced activities can be accommodated in desired growth centres outside the charged area.

18 Revenue and Financial Modelling

18.1 Introduction and main assumptions

The base tariff for the Revenue Scheme is $3 including GST. Key assumptions for the Revenue Scheme include the level of capital expenditure, traffic volumes and the scheme charge levied per day.

Table 25: Revenue Scheme key assumptions

Average annual daily traffic volumes	**FY 2016**	**FY 2021**	**FY2026**
Number of charged trips in 24 hours	121,383	127,906	134,780
Daily to annual traffic volumes			
Number of Charging days per annum	302 days	302 days	302 days
Charge per trip (escalated $, GST Incl.)			
Tariff	$3.94	$4.45	$5.04
OBUs in circulation			
Total OBUs	79,118	100,594	123,224
Maintenance costs (escalated $)			
Maintenance costs	3,270,534	3,700,309	4,186,560

Table 26: Revenue Scheme capital costs

Capital costs (2008$)	**Year 1**	**7-yearly**	**10-yearly**	**20-yearly**
Roadside equipment hardware	$13.2 m		$13.2 m	
Detailed engineering software	$18.9 m		$18.9 m	
Data communications, hardware, software, Installation	$11.3 m	$11.3 m		
Staff and call-centre set-up costs	$0.5 m	$0.5 m		
Civil works, foundations	$10.0 m			$10.0 m
Bow wave initial project costs	$3.4 m			

The traffic volumes are based on the RART model and represent the daily number of charged trips as at 2016. The Revenue Scheme is based on charging for the full 24 hours in the day, seven days a week. Only the charged trip numbers have been included here as the majority of vehicles, in particular commercial vehicles, will make multiple trips but the vehicle is charged only once in a 24-hour period. Annual growth in the number of charged trips is calculated on the percentage volume growth expected in the number of total vehicle trips entering the scheme.

The charge per trip is calculated using the $3 including GST tariff as at the base year for traffic modelling of 2005 and escalated accordingly to give an appropriate charge in 2016 dollars, 2021 dollars and 2026 dollars.

18.2 Summary of financial performance

The Revenue Scheme produces total revenue of $859m in net present-value terms over a 20-year period. This is based on a $3 charge (2005 dollars) and traffic volumes of total charged trips in 2016 of 121,383 per day over a 24-hour charging period.

The net project NPV is $658m after operating, capital and replacement costs. The annual net revenue in the first full year of operation is approximately $97m which increases over the 20-year operating period as the traffic volumes increase.

Table 27: Revenue Scheme financial results

Revenues	**Annual FY 2013**	**Total NPV** (20 Years)
Tariff revenue	$111 m	$785 m
Notice fees and other fees	$10 m	$74 m
Total revenue	**$121 m**	**$859 m**
Operating expenditure		
Maintenance costs	$3 m	$20 m
Scheme operating costs	$19 m	$106 m
Total operating expenditure	**$22 m**	**$126 m**
Capital expenditure		
OBU capex (escalated)	$2 m	$5 m
Construction capex (escalated)	N/A	$43 m
Replacement capex (escalated)	N/A	$27 m
Total capital expenditure		**$75 m**
NPV of all revenues and costs^		**$658 m**

^ All NPV values discounted at 10% over 20 years and exclude GST

The Revenue Scheme produces strongly positive cashflows which more than adequately cover expected operating and capital costs (including future replacement capital costs). Throughout the life of the project, this scheme generates substantial levels of surplus cash because of escalating tariff revenue and traffic volumes compared to a relatively small operating cost base.

The Congestion Scheme NPV, of $988 million, is substantially higher than that of the Revenue Scheme, mainly because the Congestion Scheme tariff is double that of the Revenue Scheme, while the difference in the number of daily charged trips between the two schemes, based on current scheme-design assumptions is significantly less than double. As long as the number of daily charged trips is broadly comparable between the two schemes, the variable operating costs of the schemes will be similar, and therefore the greater tariff level would flow straight through to the operating surplus.

The Revenue Scheme is still able to generate significant revenue as the per-transaction operating cost of the project is about 60 cents on average over 20 years in 2008 dollars, including capital replacement costs, and so the remainder of the $3 is net surplus revenue.

19 Travel Choice and Equity

19.1 Focus group views

The Revenue Scheme ended up scoring relatively poorly with the majority of focus group participants. In general, it was felt that the charge proposed in the Revenue Scheme was too low ("… at $3 it's a cup of coffee") to be effective enough to change travel behaviours. Almost unanimously, participants in these groups predicted that they would carry on as usual if such a scheme was introduced and it would have no material effect on their lives. The scheme was rejected on fairness and efficiency grounds and it was felt that there were more effective and simpler ways, such as fuel duties (contentious) or local body taxes, to raise revenue to fund transport initiatives.

For this reason, the consideration of ways to provide equitable travel choices concentrated on the Congestion Scheme, and has been reported in Section 10. The measures to reduce social impact discussed in that section are also applicable to a Revenue Scheme, and the conclusions reached are similar; ie that revenue targeting (primarily to public transport) offers the best combination of lowest transaction cost balanced against effectiveness in mitigating social impacts, taking into account desirable behaviour changes. As for the Congestion Scheme, it would also be possible to implement exemptions and free days of travel, noting that the focus groups were reluctant to go down this route for either scheme.

19.2 Use of revenues

Participants rejected any suggestion that revenue collected from the Revenue Scheme could be used for anything other than upgrading the transport network. Upgrades, they stressed, need to focus on public transport, the roading network and amenities that enable and encourage alternative transport such as cycling and walking. Some also referred specifically to the ferry component of the public transport system.

There was some variation among groups about how investment could be fairly distributed across public transport and roading. For instance, the Mangere group, student participants and, to a lesser extent, the Avondale group, argued in favour of more public transport investment. However, across the focus groups there was strong support for balanced investment in both public transport and roading.

20 Contribution to NZTS Targets

20.1 Introduction

An assessment was undertaken for the Revenue Scheme on the extent to which it would contribute to achievement of the targets set out in the *Sustainable Transport* document. Not all of the proposed targets were included in the assessment because there are a number of targets for which road pricing is simply not relevant.

20.2 Summary of performance

The table below compares performance of the Revenue Scheme against the 2016 'no-pricing' environment. A negative performance is marked with a cross, and a positive performance a tick. A more detailed analysis is set out in the NZTS Workstream Report.

Target	'No-pricing' scenario	Revenue
Halve per capita greenhouse gas transport emissions	☒ CO_2 emissions expected to continue to increase. No contribution to target (in fact a worsening)	☑ CO_2 emissions continue to increase but at a slower rate than under 'no-pricing'. Contribution to target of about 8% to 10% of the desired reduction.
Travel times by all modes will be predictable	— Planned heavy investment keeps travel times approximately the same as currently.	☑ Small improvement in speed and free-flow speed over the no-pricing scenario, and a reduction in the percentage of the network that is congested (from 20% to 17%), so travel times likely to be more predictable under the Revenue Scheme than without road pricing.
Travel times by principal routes to be improved relative to 2007 for identified critical intra- and inter-regional connections, as determined within each region	☒ Travel time between key economic centres is expected to increase, from an average of 15 minutes to 22 minutes in 2016.	— Very slight improvement of travel times on key routes in comparison to the no-pricing scenario. Only slight improvements to the times between key economic centres, and for car travel time to employment centres.
All individuals have access to the facilities and activities they need, such as work, education, medical care and shopping centres, to participate in society	— No improvement in number of households within 30 minutes of key economic centres in Auckland, but sector to sector travel times are expected to marginally decrease in most cases.	☑ 7% more households are within 30 minutes or more of employment over the no-pricing scenario for car and 35% for PT, and the total number of households within 30 minutes of key centres increases by approximately 7%.
Public health effects of transport to be at accepted international standard	☑ Predicted increased in active modes and move to cleaner, more efficient vehicle fleet is likely to contribute to the target.	☑ Even greater predicted increase in active modes and move to cleaner, more efficient vehicle fleet is likely to contribute towards the achievement of the target.
Local environmental impacts of transport (including air and water quality) to be at accepted international standard	— Expected decrease in air emissions over 2001 because of cleaner, more efficient vehicle fleet, but increase in run-off to sensitive catchments.	☑ Will result in a decrease in air emissions and a reduction in contaminants in runoff to sensitive receiving environments. Some contribution to the target.

Target	'No-pricing' scenario	Revenue
Reduce the kilometres travelled by single occupancy vehicles in major urban areas on weekdays by 10% per capita by 2015 compared to 2007	☒ Trip numbers expected to continue to increase.	— Only very slight reduction in vehicle trips in the AM peak (from 446,000 to 441,000). No significant increases in car passengers expected, so only minimal contribution to the target.
Increase the public transport mode share of peak- hour travel (journeys to work) in Auckland, Wellington and Christchurch from an average of 9% to 20 % and work with each region to optimise peak-hour travel targets	— No significant predicted increase in PT mode share (peak mode share expected to go from 10.5% in 2001 to 11.2% in 2016). Unlikely to contribute significantly to target.	— Only marginal increase in PT peak mode share (from 11.2% in non-priced environment to 12.7%). Some contribution to target, but not significant.
At least double the overall public transport mode share to 7% of all passenger trips (currently about 2-3%)	— No model output possible (only peak period modelled in this study), but given small peak period change, no significant contribution expected	— Based on PT mode share change in peak period, only very marginal improvement expected.
Increase walking and cycling and other 'active modes' to 30% of total trips in urban areas (currently about 17%)	— Only minimal mode share increase expected in peak period (from 14.4% to 15.6%), so no significant contribution to target expected.	— Peak period mode share increases from 14.4% to 15.9% across whole Auckland network (but only very marginal improvement over non-pricing result, which is 15.6%). In the charged area (central urban) share expected to be higher, so some contribution to the target is expected.
Ensure a substantial reduction in premature deaths and serious illnesses arising from air pollution from motor vehicles	☑ Expected to be a contribution to the target as a cleaner, more efficient feet is effective in reducing emissions following expected technology improvements.	☑ Expected to contribute to achievement of the target. Modelling shows reductions of between 4.3 and 10.8% (compared to no-pricing) for NOx, PM10 and VOC.
Manage noise to minimise any public health effects	☑ Improvements to motorway networks are predicted to result in lower traffic volumes, and therefore noise, on selected arterial network. Will contribute to target.	☑ Performs almost exactly the same as the 'no-pricing' scenario.

The table shows that the Revenue Scheme will make some contribution to a limited number of the proposed NZTS targets. Nevertheless, even a small charge such as that envisaged in the Revenue Scheme can provide an incentive to use public transport, by encouraging motorists to shift modes, thereby providing the impetus to improve the coverage and frequency of the PT network, which will be a key contributor to achieving some of the NZTS aims.

21 Technology

21.1 Introduction

The main purpose of the charging mechanisms assessment was to build on the work undertaken during ARPES, and to provide direction on the suitability of charging mechanisms and technology choices for the two schemes to assist the broader evaluation process.

21.2 Technology choice

The Revenue Scheme is a cordon scheme. Cordon schemes generally involve charging vehicles that cross a defined boundary line, with the aim of reducing congestion on routes leading into and through the cordoned area. Charges can be fixed at a single known rate (for any given vehicle type) with only one payment required per day, or varied by time, actual or expected level of congestion, or across charging points so that it would cost more to cross the cordon at charging points where congestion is higher. In this context, from a 'fitness for purpose' perspective, the main requirements of the Revenue Scheme can be summarised as follows:

- Capacity to monitor vehicles moving in both directions and identify by direction.
- Need to manage a relatively high number of boundary points with majority located in urban street environments.
- Addressing of urban street and highway environments.
- Full-time operation and high system reliability.
- Capacity to identify qualifying exempt vehicles and provide for a range of account and special purpose concession schemes.
- Matching and consolidating trips.
- Lower single charge level may affect business case (if processing multiple transactions for each $3 charge).
- Additional internal points and potential mobile enforcement levels to be balanced with cost and deterrent effect.
- Optimisation of revenue collection through efficiency of operations and reliability and accuracy of collection processes.
- Provision of charging mechanisms that meet public expectations of simplicity and fairness.

From these requirements, several technology options were evaluated. The first stage assessment of these options against the broad requirements of the Revenue Scheme eliminated both paper-based and manual tolling as potential methods, concluding that these types of facilities would present difficulties of traffic disruption and limitations on any future ability to vary charges by time of day and level of congestion. Global navigation satellite systems (GNSS) were identified as technically possible, but not currently cost-effective.

The conclusion of the first level assessment was that the only feasible options for implementation were a Dedicated Short Range Communications (Tag and Gantry) system (DSRC), Automated Numberplate Recognition (ANPR) or a combination system. Table 28 on the next page presents the results of this first evaluation.

Table 28: First level assessment of options for Revenue Scheme

Revenue Scheme	
Paper-based system	Not recommended because of the scale of the system, the large number of cordon points and feasibility of enforcement
Manual toll-plazas	Not recommended. Location and delays from charging points, traffic and safety issues would outweigh any benefits.
ANPR	Potential option to be evaluated in greater detail.
DSRC	Best current option. Similar to the model adopted for Singapore. Infrequent-user issues would need to be resolved.
Vehicle positioning GNSS systems (GPS, Galileo)	Technically possible, but not cost-effective currently. Issue of infrequent users would need to be addressed. Costs would need to be balanced with greater capacity to differentiate charges by time and location.

A more detailed assessment was then undertaken against a series of additional criteria:

- Fitness for purpose
- Risks and mitigation
- Capital and operating costs
- Alignment with TSP
- Procurement issues
- Lessons from international review.

Based on the more detailed assessment, a system using a DSRC tag solution with an ANPR enforcement facility was identified as the most suitable option, with a number of key factors influencing the decision:

- High proportions of regular users, and expected high take-up rates for DSRC payment, increasing the cost effectiveness of a DSRC solution and reducing overall operating costs.
- Expected reducing future capital costs.
- Improved overall system reliability and accuracy leading to higher net revenue.
- Improved convenience and security for users.
- Alignment with the Toll Systems Project Solution for the ALPURT toll road.
- Future flexibility and reliability.

The selection of a DSRC system for the Revenue Scheme provides a flexible and reliable system that can effectively charge all vehicles moving across the defined boundaries. This type of system also offers more flexibility, an improved ability to differentiate vehicle types and functions, improved opportunities to address exemptions, high levels of reliability and security, and the potential for a wider choice of payment methods and structures to suit individuals.

These conclusions are consistent with, and therefore confirm, the findings in the ARPES 2006 work, and are consistent with the development of an electronic tolling capability in the Toll Systems Project. Further detail on the comprehensive evaluation process undertaken, including consideration of operational systems around the world, and the bottom-up development of technology costs to be used in the financial analysis, are available in the Charging Mechanisms Report.

Part 4: Conclusions and Next Steps

22 Congestion Scheme - Summary

22.1 Achievement of the core objective

The objective of the Congestion Scheme is to reduce congestion in Auckland during the morning peak period with a particular focus on the central Auckland area, and to increase trips made by public transport and active modes. Overall, the results of the transportation modelling show that the scheme has met these objectives.

Trips generated	Significantly fewer trips are generated in the region every weekday morning (about 10%, or nearly 43,000 trips), and total vehicle kilometres travelled during the peak period also reduce significantly (also about 10%).
PT and active modes	Public transport and walking and cycling mode shares increase significantly, with public transport going from 11.2% of total trips to 15% (an increase of a third), and walking and cycling going from 15.6% of total trips to 18%. This increase shows the extent to which the active modes can be a feasible travel alternative in the compact charging area.
Speeds	Average speeds throughout the entire regional network increase from 39.6 km/hr to 43.3 km/hr (an increase of nearly 10%). Speeds in some sectors are much higher (for instance, in the northern sector, including across the Harbour Bridge) and the average speed increase is a significant 25% (from 37.6 km/hr to 47.3 km/hr).
Congestion	There is a significant decrease in the percentage of the network that is congested (from 20% down to 13%).

22.2 Performance against broader objectives

The Congestion Scheme also contributes to broader environmental and economic objectives and, in particular, makes a strong contribution to the targets set out in the NZTS.

Environment outcomes	Significant reductions in traffic volumes on key roads in the central Auckland urban area are possible, along with reductions in traffic volumes on main arterials in the North Shore, improving the quality of these environments significantly. Discharges to sensitive water environments are likely to be reduced. Although air emissions are predicted to decrease from 2001 levels through to 2016 and 2021 even without road pricing, the scheme is expected to result in further reductions in emissions, particularly inside the charging area. CO_2 emissions continue to increase but at a slower rate than under 'no-pricing', with the scheme providing a significant contribution of about 26% to 30% of Auckland's share of the desired reduction in greenhouse gas emissions set out in the NZTS.
Economic outcomes	The current levels of congestion are a major issue for a wide range of businesses in Auckland. In particular, the survey of road carriers shows that they are particularly adversely impacted by congestion which is significantly reducing their productivity and profitability. Overall, however, there are winners and losers and consequently the economic outcomes of the scheme are likely to be relatively neutral or marginally positive.
Land use outcomes	The scheme is likely to see a noticeable reduction in the relative cost of access to Regional Growth Strategy growth areas, by vehicle. This should make these centres much more attractive for business location. The scheme should assist with a higher quality environment for business activities within the core CBD and Newmarket areas, strengthening the agglomeration process, provided that public transport services are improved. Residential property impacts are likely to be modest.

NZTS outcomes	The scheme will be a strong contributor to a number of the proposed NZTS targets, including some that will be difficult to achieve in a non-priced environment. In general, road pricing can also provide an incentive to use public transport by encouraging motorists to shift modes, thereby providing the impetus to improve the coverage and frequency of the PT network, which will be a key contributor to achieving some of the NZTS aims. Finally, road pricing also presents the opportunity to provide incentives to achieve other targets, such as providing exemptions for electric or biofuelled vehicles.

22.3 Response to the issues raised in submissions

The Congestion Scheme also responds well to the issues that were raised by submitters.

Passenger transport as an alternative	The analysis undertaken shows that the funded PTNP being implemented by ARTA will, with a few adjustments, provide a reasonable alternative to commuting into the charge zone by private car and paying a charge. If a $6/day charge is implemented then most of the Auckland region would able to access the charged zone at approximately the same generalised cost (combination of time and out-of-pocket cost) whether they choose a car trip or a passenger transport trip (with some exceptions, which would be addressed in a detailed design exercise, assuming application of some of the revenue generated to public transport). Should a Congestion Scheme be adopted, the main focus would need to be on improving relative travel times between car and public transport trips, because for a number of trips, using a car will be faster than PT, although on longer trips where rail is involved PT times become more competitive.
Affordability and social equity	Modelling of the impact on households of the Congestion Scheme shows that there will not be large social impacts, and those impacts that are expected can be managed. For most households there will be a viable PT alternative to access the charged area during the morning peak period, so there is a choice of whether to pay the charge or not (without even considering the improvements to PT that would be expected from using the revenues from the scheme). The household impact analysis shows that for 92% of all households, the additional out-of-pocket impact of the Congestion Scheme is either nil, very low or low (2% or less of net household income) – only 2.4% of households will bear an impact of more than 4% and none more than 5%. Most commonly impacted households are couples (23%) and multi-adult households (21%). By restricting the charging time to 6-10am, Monday to Friday, means that only 19.1% of Auckland households are impacted at all, with nearly 420,000 households not impacted.
Impacts on commercial and retail areas in central Auckland	Taking into account the full range of issues such as access to labour, productivity and profitability, the results of the surveys undertaken suggest that retailers and other businesses are fairly evenly split on whether the scheme would have positive or negative impacts. A key finding is that the schemes are likely to result in winners and losers – some firms will gain customers, others will lose them, and equally, some firms are likely to find it easier to attract employees while others will not.
Provision of viable alternative to SH1	A completed Western Ring Route (alternative to SH1) was included in the base network modelled, providing an alternative to SH1 through the charged area. An assessment was also undertaken of the possible number of 'through trips' that could be exempted on SH1 (similar to the exemption for 'through trips' in the Stockholm Scheme). This assessment showed that perhaps only 3-4% of trips would not be charged if the decision was made to exempt these trips, meaning that the revenue impacts of providing this facility would not be significant.

Treatment of revenue	The Congestion Scheme, as modelled, would generate net revenue of approximately $150m in its first full year of operation, increasing over time. This Report has not considered or made recommendations on the use of these revenues, but it is clear that these funds could be used to make significant improvements to transport infrastructure in Auckland. The technology workstream showed that the system could be implemented cost-effectively, and in a way that is consistent with the emerging Toll Systems Project. Focus groups convened for this phase of work exhibited strong consensus that all money raised in any road-pricing scheme adopted in Auckland should be spent in Auckland on transport (either as capital expenditure or as subsidies for public transport).
Ability to provide exemptions	The focus groups also had mixed views on exemptions – three out of the five groups concluded that exemptions were not desirable. Exemptions were seen as being counter to the objectives of the scheme in terms of both revenue raising and congestion reduction, open to abuse and counter to participants' sense of equity and fairness (which leaned towards the need for universality in the application of any scheme). If exemptions were to be adopted, the technology recommended (using tags and gantries) was in part due to the capacity to assign a lower charge or a free day of travel to a particular tag. Doing so would have an impact on revenues collected (possibly up to 20-25%, depending on the exemptions adopted) and there would need to be careful checks to ensure that the system was not abused.

22.4 Conclusions

This Report does not aim to make recommendations. Nevertheless, in summary, it is clear that the Congestion Scheme, in parallel with other initiatives, would be a strong contributor to the achievement of national and regional transport objectives. It would reduce congestion, encourage the growth of public transport and active modes (walking and cycling) and generate improved environmental outcomes throughout the region. The scheme would yield significant net revenues, providing additional funding for road and PT network upgrades in Auckland. The analysis has also shown that in the absence of pricing it will be difficult to continue improving transport outcomes beyond 2016 (ie despite significant investment, congestion levels stay about the same), and to achieve the NZTS outcomes sought, particularly the environmental and energy-use outcomes.

Most importantly, the submissions made on the ARPES study, indicate it is likely that the scheme could be implemented in a way that would not have significantly adverse impacts on Auckland businesses or households. Based on the surveys of retailers, road transport organisations and other businesses, on balance, the impacts on retailers and other businesses are perceived as likely be neutral, with positive outcomes for road carriers. The scheme has no impact at all on more than 80% of households in Auckland, and for 92% of households the out-of-pocket scheme impacts are either nil, or less than 2% of household income.

The analysis has also shown that the planned public transport network in Auckland for 2016, with some targeted improvements, would provide a reasonable alternative for most trips into the charged area. While there remain some trips for which public transport is a less-effective option, particularly to the edges of the charging area, there are solutions contained in the analysis. The planned passenger transport network design would provide a strong base for improvement using the revenues gathered from the scheme – a detailed design process would allow services to target particularly those areas where a higher level of public transport service is required to provide an alternative to paying the charge. Additionally, focus groups undertaken during the study concluded that there are no significant barriers to responses other than public transport, such as carpooling and changing travel times, and up to half the focus group participants indicated that these responses would be options for them. The travel choice analysis also showed that it would be possible to implement exemptions for particular groups and free days of travel.

When these results are combined with the results of the public transport analysis, it is reasonable to conclude that, for a vast majority of Aucklanders, there either are, or would be, reasonable options open to avoid paying the charge, and also to conclude that there is an ability to target any specific exemptions to at-risk groups. These results, combined with the limited financial impacts on households, provide a strong response to the issues raised in submissions on the ARPES study.

23 Revenue Scheme - Summary

23.1 Achievement of the core objectives

The objective of the Revenue Scheme is to generate revenue for transport-related projects by charging users directly for the use of highly congested roads in Auckland, while minimising or avoiding negative social or economic impacts. Overall, the results of modelling show that the scheme has met these objectives.

Revenue generation	The scheme as modelled could generate around $100 million of net revenue in its first full year of operation, increasing over time. This report has not considered use of these revenues, but is clear that these funds could be used to make significant improvements to transport infrastructure in Auckland. The scheme can be implemented cost effectively.
Trips generated	Slightly fewer trips are generated in the region, and total vehicle kilometres travelled during the peak period reduce also. Both impacts are marginal, with reductions of about 1.5%-3%.
Speeds	Even with the low charge, there is an improvement in overall network speeds of about 5%, from 39.6 to 41.5 km/hr. The main improvements are in the northern sector and across the Harbour Bridge, with increases from 37.6 to 44.3 km/hr (an 18% increase).
Congestion	There is also a decrease in the percentage of the network that is congested (from 20% down to 17%).

23.2 Performance against broader objectives

The Revenue Scheme also contributes, although not to the same extent as the Congestion Scheme, to broader environmental and economic objectives, and to the targets set out in the NZTS.

Environment outcomes	Some reductions in traffic volumes on key roads in the central urban area and on the North Shore are possible, improving the quality of these environments. Discharges to sensitive water environments are likely to be reduced somewhat, and the scheme is expected to result in reductions in emissions over what can be expected from improvements in fuels and the vehicle fleet, particularly inside the scheme area. CO_2 emissions continue to increase but at a slower rate than under 'no-pricing', with the scheme providing a contribution of about 8% to 10% of the desired reduction in greenhouse gas emissions set out in the NZTS.
Land use outcomes	The Revenue Scheme has a modest impact on the relative cost of access by vehicle to Regional Growth Strategy growth areas, with slightly larger benefit for public transport users. However, the figures suggest no significant difference in terms of transport's influence on the desirability of the Regional Growth Strategy centres as business or residential locations, at a regional level. Overall, the Revenue Scheme should assist slightly with a higher-quality environment for business activities within the core CBD and Newmarket areas, strengthening the agglomeration process, provided that public transport services are improved. For other business areas on the fringes of the CBD, but within the charged area, the scheme may be a disadvantage, particularly for retail, manufacturing and distribution activities that rely on customers from inside and outside the scheme boundary for their viability. For businesses in these areas there may be some pressure in the future to relocate to outer isthmus business areas. Residential property impacts are likely to be modest.

Economic outcomes	There would be winners and losers from the Revenue Scheme and the overall impact depends on how the revenues collected are allocated. A reduction in congestion is a positive factor, particularly for road carriers. However, the nature of the scheme means there may be marginally more adverse impacts on retailers and other businesses inside or near to the scheme boundary, which would tend to have a redistributive effect.
NZTS outcomes	The scheme will contribute to some of the proposed NZTS targets, although not as strongly as the Congestion Scheme. Nevertheless, even a small charge such as that envisaged in the Revenue Scheme can provide an incentive to use public transport, by encouraging motorists to change modes, which will be a key contributor to achieving some of the NZTS aims.

23.3 Response to the issues raised in submissions

The Revenue Scheme also responds well to the issues that were raised by submitters.

Passenger transport as an alternative	Modelling of the Revenue Scheme shows that only 5,000 fewer vehicle trips per day are undertaken, which are easily able to be accommodated by the public transport services. Further, the PTNP being implemented by ARTA from already available funds will provide a reasonable alternative for those who choose not to pay the scheme charge. Focus groups strongly concluded that behaviour would not change significantly (borne out in the traffic modelling results). Assuming that the revenues generated by the scheme would be largely targeted to public transport, this would further improve PT as a viable alternative, particularly for commuters.
Affordability and social equity	For 91% of all households in the Auckland region, the additional out-of-pocket impact of the Revenue Scheme is either nil, very low or low (2% or less of net household income). There are, however, some households that would be impacted reasonably strongly, with around 1% of total households (5,700 households), incurring an additional out-of-pocket impact in excess of 5% of net household income.
Impacts on commercial and retail areas	Impacts are likely to be fairly neutral. Retailers consider the impacts will be slightly negative but that there will be winners and losers. In particular, more retailers thought a Revenue Scheme would reduce rather than increase their number of customers (32% reduced vs 15% increase), 19% thought it likely that the average sales per customer would reduce and there was a fairly even split between retailers who thought that the frequency of customer visits would reduce (29%) or increase (21%). For other businesses, overall, the balance of winners and losers, in relation to employee costs and ease of retention, customer access and impact on turnover, appears to be relatively neutral.
Provision of viable alternative to SH1	As noted in the discussion on the Congestion Scheme, a completed Western Ring Route was included in the base network modelled, providing an alternative to SH1 through the charged area. Given the low charge, it was not seen as necessary to exempt those travelling through the charged zone on SH1, and this option was not considered.
Treatment of revenue	Focus groups exhibited strong consensus that all money raised in any road-pricing scheme adopted in Auckland should be spent in Auckland on transport (either as capital expenditure or as subsidies for public transport).
Ability to provide exemptions	As for the Congestion Scheme, the focus groups shared a strong consensus that there should not be incentives or free travel rights granted, and had mixed views on exemptions – with both seen as being counter to the objectives of the scheme in terms of both revenue raising and congestion reduction, and open to abuse. Nevertheless, the technology recommended (using tags and gantries) would have the capacity to provide exemptions; for example, by assigning a lower charge or a free day of travel to a particular tag.

23.4 Conclusions

The Revenue Scheme met its objectives. It would yield significant amounts of revenue to be used for improving transport networks in Auckland, and would do so in a way that would have only minimal social impacts. Although to a lesser extent than the Congestion Scheme, the Revenue Scheme would also provide a further incentive to use an improved public transport system, and over time would encourage more sustainable land use and travel choices. A Revenue Scheme could also be seen as an enabler of the suite of initiatives required to deliver the desired transport network in Auckland.

The advantage of the scheme, when compared to other collection mechanisms such as fuel tax, is that it would concentrate the collection of revenue from those road users using the most congested parts of the network, and the revenues could then be put back into the parts of road and public transport networks most likely to benefit impacted households (80% of households are not impacted). This would send signals to those users that, should they choose to use the road network at peak times in the most congested areas, they will pay more than others who do not use the network at those times, and therefore fund more of the improvement costs. It is interesting to note that the Revenue Scheme was not popular with the focus groups held in Auckland, where participants noted that there were easier ways to collect revenue, and they were concerned that the scheme would have little impact on congestion.

Annexes

Annex 1: Findings from ARPES 2006

Introduction

This annex summarises the key findings of the ARPES 2006 study. Given that the 2008 study builds on the 2006 analysis in a number of cases, it is important to understand the findings of the earlier work. This summary of the 2006 work is of necessity limited; for detailed information the original reports should be consulted. They are all available on the Ministry of Transport's website.

The ARPES 2006 study examined the feasibility and desirability of implementing a road-pricing scheme to reduce congestion across the wider Auckland region, and to raise revenue. The work assessed the potential of four road-pricing schemes and a parking scheme to reduce congestion and raise revenue, and to positively contribute towards the achievement of the NZTS objectives. The 2006 work focused more heavily on the *desirability* of implementing a road-pricing scheme in Auckland. *Feasibility* was examined at a high level only, because the study found that technical 'implementability' is largely proven for the types of schemes considered, given that many free-flow toll roads (ie toll roads where there is no requirement to slow or stop to make payment) and several road-pricing schemes are in operation internationally.

Schemes considered

ARPES 2006 evaluated five potential road-pricing schemes for Auckland. The schemes are shown in summary form below. Each of the diagrams illustrates the boundaries, or areas where the charges would apply, along with a short description of the charges that were used for the purposes of the transport modelling and subsequent social, economic and environmental analyses.

Consideration was given early in the project to a Toll Lanes Option and Full Network Charging Scheme, but these were discounted because of technology and scheme design issues.

Single Cordon Scheme

Charges vehicles that cross a single, defined cordon (inwards travel only). Charges would not apply to travel entirely within the cordon.

Pricing levels: $6 on Harbour Bridge. $3 elsewhere. Maximum charge $6 per day.

Double Cordon Scheme

Charges vehicles that cross either of two cordons (inwards travel only). Charges would not apply to travel entirely within either cordon.

Pricing levels: Inner cordon charge ($3 per day) and outer cordon charge ($3 per day). Harbour Bridge $6 per day. $3 per day charge for travel along SH20. Maximum $3 per day charge for use of SH20 and/or crossing outer cordon boundary. Maximum charge of $6 per day for multiple crossings.

Area Charge

Charges vehicles entering or travelling within a defined area.

Pricing level: $5 per day

Strategic Network

Charges vehicles that use motorways and major limited access arterial routes.

Pricing levels: Charges applied to points of congestion and based on Levels of Service in the 2016 unpriced network. Ranges from no charge to $0.25 per km for most congested links. Maximum charge $6 per day.

Parking Charge

Parking levies for parking on public and private property within defined areas, in addition to any parking charges already in place.

Pricing levels: Revenues calculated using $10 per trip terminating in the designated parking charge zone but with driver behaviour and congestion results based on $5 per terminating trip (assumed that only 50% of road users would pay the charge directly (and hence change their behaviour) with the balance of parking charges collected from carpark owners and employers).

Overall findings

Transportation modelling undertaken for ARPES 2006 allowed comparison of the 2001 network conditions against the 2016 conditions reported in the study. The 2001 model showed a total demand of around 358,265 trips compared with the 2016 'no-pricing' outcome of 446,299 trips (which includes substantial investment in roading infrastructure, public transport and other non-pricing demand management measures). This indicated an increase in traffic demand of about 1.5% per annum, or congestion about 20% higher by 2016 than under current conditions, even allowing for planned investments in roads, passenger transport and other measures.

To varying extents, the five schemes all had positive impacts on the levels of congestion, travel times and environmental outcomes. All schemes showed an improvement of about 25% in public transport times. All schemes considered had potential to deliver even stronger transportation outcomes, but the decision was made to keep charge levels relatively low, in order to minimise the possible negative social impacts.

The economic impacts of the schemes on business activity were anticipated to be relatively benign, although it was thought that the area scheme may have some impacts on central city businesses.

ARPES 2006 found that the Single Cordon, Double Cordon, Area, and Strategic Network charging schemes all share a preferred technological solution based on Dedicated Short Range Communications (DSRC) with on-board transponders, combined with ANPR facilities for enforcement and as a payment option for casual users. The primary reasons for this choice were that:

- this is proven technology
- it provides a low average transaction cost as DSRC tends to have lower operating costs and most users will be regular users (most likely transponder users)
- there is a non-transponder-based option for infrequent users, or those travelling through the region
- DSRC is based on open standards, enabling sourcing from various vendors

- the choice was aligned with the technologies and processes being developed for the Transit New Zealand / Land Transport New Zealand Toll Systems Project.

The primary mitigation approach recommended in ARPES involved improvements to the public transport system. The nature of these improvements varied between the schemes, to ensure that good public transport options existed for as many charged trips as possible. ARPES 2006 noted that, even with public transport improvements, there will be groups for whom pricing imposes considerable financial hardship. For these groups, a system of financial compensation was proposed, using electronic vouchers issued by the agencies responsible for assessing need. Means testing was not recommended. Improvements to walking and cycling facilities were also seen to be required as a mitigation action. Again, these would vary between schemes, but were seen to be particularly important for the Area and Parking schemes.

All schemes would generate revenue to assist in developing mitigating infrastructure and services, and potentially contribute towards the development of transport networks across the region. All schemes had a positive net present value given their estimated revenues and costs. The Area scheme had the highest NPV of $804.8m (discounted to 2006).

Scheme-specific findings

The table below shows the main findings on the comparative performance between the five schemes.

Table 29: Scheme comparisons from ARPES 2006

Single Cordon	The Single Cordon scheme would be the easiest to implement from a technical perspective and also showed good congestion benefits across a range of indicators. Because of the cordon location being essentially a ring around the Auckland isthmus, the extent of adverse diversion impacts would be less than under the Area scheme (primarily because there are no alternative routes). Cash flows were reasonably strong, but were 25-30% less than those generated by the Area and Double Cordon schemes; potentially not sufficient to cover mitigation costs. Social impacts were seen to be difficult to mitigate effectively for this scheme due to the cordon separating large numbers of low-income/high deprivation index households (mostly in south and west Auckland) from places of employment, with only limited possibilities for improvements to public transport to overcome the access and mobility issues this creates.
Double Cordon	The Double Cordon scheme was considered to be the next easiest to implement, although the requirement to also charge a toll for trips across the inner cordon and along SH20 adds a degree of complexity. This scheme provided the best overall congestion benefits across a range of indicators but did not encourage a shift to other modes as well as the Area scheme. There were expected to be some diversion effects along SH20 and along the perimeter of the inner cordon (the latter being similar to the Area scheme). Social impacts were seen to be difficult to effectively mitigate for this scheme for similar reasons to the Single Cordon with the added complexity of an inner cordon. Cash flows were very strong and met the costs of mitigation measures proposed.

Area	The Area scheme generated strong cash flows and showed good congestion results across a range of indicators, particularly switching to public transport. However, it was seen to be necessary to mitigate against the diversion to certain ring roads around the boundary of the Area. Social impacts were considered to be largely able to be mitigated for this scheme because fewer high-social-deprivation households were impacted than with the Cordon schemes. Access and mobility challenges were reduced by the focus on the CBD, which has good public transport access, with required improvements being relatively straightforward. This scheme was seen to have the largest impact on business trips.
Strategic Network	The Strategic Network Charging scheme had minimal adverse social impacts compared with the other schemes. Its main drawback was the diversion impact of traffic onto the local road network. Furthermore, because charges were set low to minimise this impact, the Strategic Network Charging scheme also failed to generate strongly positive net cash flows and consequently raised insufficient revenues to fund mitigation strategies, primarily in the form of enhanced local road capacity.
Parking	The Parking Levy scheme produced modest congestion reduction results. Financial results were reasonably good because of low collection costs and low mitigation costs. There are significant implementation challenges which would need to be worked through in order to make this scheme workable. There were no significant adverse impacts on businesses and it appears that impacts on households could largely be mitigated.

For detail on the performance of the schemes, refer to the Executive Summary and Full Report of ARPES 2006, available on the Ministry's website.

Annex 2: Process and methodology

Introduction

This annex provides details of the analysis process followed, including, in particular, details on the schemes to be assessed, and the early analysis undertaken to confirm their characteristics for the purpose of the study.

Schemes assessed

The Ministry's aim was to assess two different schemes that represented two very different approaches to pricing in Auckland; one with a clear focus on reducing peak hour congestion in Auckland and one focused on collecting revenue to assist the funding of required transport-system improvements, without imposing any significant social or economic impacts.

The two schemes are broadly based on the Area scheme from ARPES 2006 (as discussed in Section Four). The Congestion Scheme (as an area charge) is consistent with the ARPES 2006 Area scheme, and the Revenue Scheme (a cordon) has the same boundaries. The reason for focusing on the Area scheme boundary is that, of all the schemes considered in ARPES 2006, the Area scheme was deemed to be the most likely for which adequate passenger transport alternatives could be satisfactorily provided. In order to determine whether the concerns of submitters could be addressed satisfactorily, it was decided to use the ARPES 2006 Area scheme as the basis for further analysis because if the concerns could not be addressed for this scheme, it was unlikely they could be addressed for any other scheme.

Broadly, the differences between cordon charging and area charging are as follows:

- **Cordon charging:** Cordon schemes generally involve identifying an area of major congestion, drawing a line around that area, and charging vehicles that cross that line, in order to reduce congestion on routes leading into and through the cordoned area. Cordon schemes influence only traffic which passes across the cordon and not traffic circulating inside the cordon. Consequently, congestion reductions rely largely on changes in the behaviour of commuters who travel into the cordon from areas outside it or vice-versa. The Stockholm scheme is an example of a cordon scheme.
- **Area charging:** Area schemes are similar to cordon schemes in that they identify an area of major congestion, draw a line around that area and charge vehicles that cross that line, in order to reduce congestion on routes leading into and through the defined area. The major difference is that with an area charge, vehicle drivers who travel entirely within the scheme boundaries are also charged. The best-known area scheme is the London Congestion Charging scheme, which commenced operation in early 2003, and has recently been expanded. Congestion reductions outside the charging area are similar to those of a cordon scheme but, as area schemes influence traffic circulating inside the area, congestion reduction inside the area is higher than that of the cordon schemes.

The specific characteristics of the two schemes used for the purposes of this study are discussed below.

Revenue scheme

The primary objective of the Revenue Scheme is to generate revenue for transport-related projects by charging users directly for using all or part of the transport system, while minimising or avoiding negative social or economic impacts. In this case, road users are charged for crossing the boundary in either direction. The imposition of a charge will have limited

congestion-reduction and mode-share benefits, but the Revenue Scheme would not focus on peak period travel, and would charge any vehicle entering or leaving the charged area at any time of the day, in order to raise revenue.

It was decided to assess the Revenue Scheme based on what is commonly referred to as a cordon scheme with a small cordon tightly focused on the CBD, operating 24 hours a day, seven days per week, and charging all vehicles (cars, motorbikes, taxis and trucks) except buses which receive a 100% discount.

To minimise social and economic impacts the charge level was set at $3 per trip with a maximum $3 charge per day (ie one payment covers multiple entries and exits).

Initially for the Revenue Scheme a number of base parameters were agreed:

- The scheme charges would be set low, and would apply seven days a week, 24 hours a day. Lower charges mean less need for significant investment in public transport or other mitigation strategies because of lower costs per impacted household and therefore lower social impacts.
- The aim of the scheme would not be to maximise revenue, since this would inevitably impact on lower-income households, but rather to provide a ‘solid starting base’ of revenue which could be used to improve the transport system in Auckland.

There was initial discussion about whether a narrower or wider charging boundary should be used (the inner cordon or the outer cordon, as specified in the Single Cordon scheme in ARPES 2006). After consideration, the inner boundary was agreed on, because:

- the isthmus cordon places a barrier between lower socio-economic residential areas in the west and the south from significant employment areas (and the aim of the Revenue Scheme is to have few or no social impacts, and at the same time provide another way of raising revenue for transport improvements in Auckland)
- having identical boundaries provides a useful means of comparison for the differences in performance and effects for the Congestion Scheme and the Revenue Scheme.

Other options for a Revenue Scheme (including full network charging and a double cordon option) were also considered early in the study. In summary, the key reasons for opting for the recommended inner cordon scheme were that, compared to others, it is relatively simple to understand, comparable to the Congestion Scheme also being considered, technically feasible, relatively low cost, and, because of the relative strength of passenger transport in the central isthmus, probably the most consistent with the objectives of the Revenue Scheme.

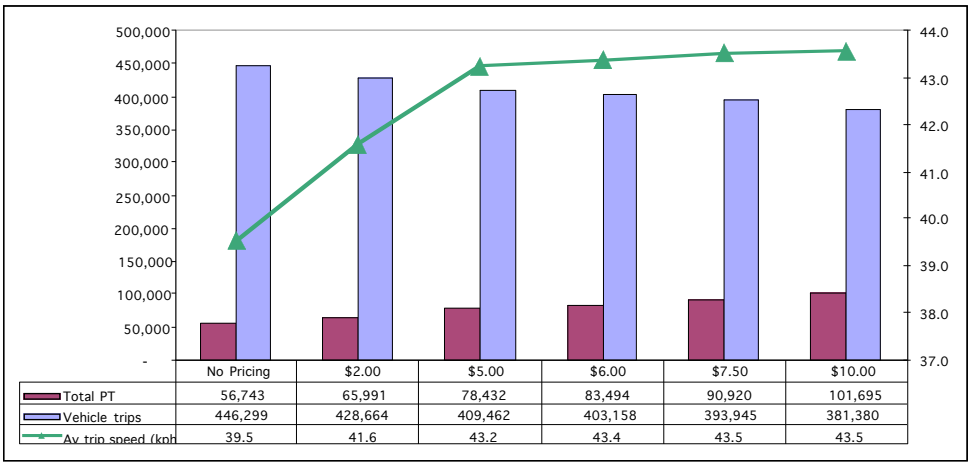
Congestion scheme

Several important parameters of the Congestion Scheme were discussed and agreed early in the study:

- It was agreed that the Area scheme from ARPES 2006 was the most suitable for further analysis, primarily because it was seen to have the highest likelihood of being able to provide a reasonable set of passenger transport alternatives.
- It was agreed that a single charge per day would apply. That is, multiple entries and exits of the system would be charged only once.

To arrive at the charge to be set for the purpose of the study, the ARC developed proxy indicators of congestion reduction (such as network speed, percentage of the network in level of service E and F, % congested VKT), to use in testing different charge levels. The results of that testing are shown in the figure 31 below.

Figure 31: Testing of charges for the Congestion Scheme



	No Pricing	$2.00	$5.00	$6.00	$7.50	$10.00
Total PT	56,743	65,991	78,432	83,494	90,920	101,695
Vehicle trips	446,299	428,664	409,462	403,158	393,945	381,380
Av trip speed (kph	39.5	41.6	43.2	43.4	43.5	43.5

After that testing it was decided that the Congestion Scheme should have the charge set at $6 for the purposes of the study. There were two reasons for this:

- The model runs conducted by ARC showed a reasonable further improvement in the percentage of travel undertaken in congested conditions (levels of service E and F) as a result of increasing the charge from $5 to $6
- It further differentiates the Congestion Scheme from the Revenue Scheme to have the charge for the Congestion Scheme at twice that of the Revenue Scheme.

Congestion scheme

The objective of the Congestion Scheme is to reduce congestion, particularly during the morning peak period and within the highly-congested central Auckland area. The pricing philosophy adopted for the scheme is to charge all vehicles entering the scheme and those moving within the charged area during the morning peak period. This pricing concept should deter vehicles from travelling during the charged period as the cost of travel is higher. This aims to have the broad effects of reducing peak car-travel demand, re-timing trips to non-charged time periods, increasing ride sharing, increasing trips made by public transport and active modes, and influencing travel behaviour by redistributing trips (destinations may change, or routes used may change).

The Congestion Scheme is what is commonly referred to as an Area scheme. This involves a charge when crossing the charging area boundary in both directions as well as a charge for movement within the charging area. The Congestion Scheme assessed is assumed to operate from 6am to 10am, five days per week, and it charges all vehicles (cars, motorbikes, taxies and trucks) except buses which receive a 100% discount.

To provide a meaningful congestion reduction, the charge level was assessed at $6 per trip with a maximum $6 charge per day (ie one payment covers multiple entries and exits). Changes to behaviour during the morning peak period is also expected to influence congestion in the evening peak period because of mode shifts in the morning.

Workstreams

To provide the additional analysis required, a work programme was structured to include traffic modelling, public transport analysis, economic analysis (including case studies), financial modelling, assessment of social, environmental and land use impacts, technology and cost issues, and assessment of travel choice and equity options other than passenger transport.

The individual workstreams were conducted by experts in their fields, coordinated by the Ministry of Transport.

The workstreams, along with those undertaking the analysis, were as follows:

- Traffic modelling was undertaken by the Auckland Regional Council using the ARC traffic models. This workstream focused on understanding the congestion and other transport impacts of road pricing, and providing key traffic inputs to the other workstreams.
- Public transport analysis was undertaken as a joint exercise between the Auckland Regional Transport Authority and the Ministry. This work focused on understanding the extent to which passenger transport could provide meaningful alternatives to those likely to be impacted by the implementation of road pricing in Auckland.
- Economic analysis and case studies were undertaken by Pricewaterhouse Coopers (PWC) and the New Zealand Institute of Economic Research (NZIER). ARPES 2006 looked at the overall economic impact of road pricing in Auckland. The work in this stage has gone into greater detail considering the impact on road transport carriers, CBD retail, CBD business, and other areas of the economy. It uses international evidence as well as direct research from discussions with Auckland businesses.
- Financial modelling was undertaken by Deloitte. This work updates the financial modelling undertaken in ARPES 2006 and compares the relative financial outcomes for the two pricing schemes considered.
- The workstream considering environmental and land-use impacts was undertaken by Hill Young Cooper. The aim of this workstream was to gain an understanding of the impacts that road pricing has on the environmental performance of the transport system in Auckland (with particular reference to recently released government targets) and on land-use patterns within the Auckland region.
- The workstream considering technology and charging mechanisms was undertaken by Hyder Consulting. This workstream looked at the charging mechanisms that could be used, with particular consideration of recent developments in road tolling in New Zealand, and provided information to the workstream developing the financial modelling of capital costs and rates of detection that impact on revenue collection.
- Market Economics undertook the workstream that assessed the impact of the two schemes on Auckland residents and households. The social impacts assessed arise from the number of trips or households impacted and the costs and savings made by the households (either direct costs, public transport costs, parking costs, time costs or vehicle-operating costs).
- Work on travel choices and equity options was undertaken by Hyder Consulting. This work focused on the identification of options other than passenger transport to provide alternatives to car use and/or to mitigate the negative impacts of a charge (eg, exemptions, discounts and entitlements).

Full details on the approach followed in each of the workstreams is contained in the individual workstream reports.

Annex 3: Detailed Public Transport Analysis

This annex sets out the detailed evaluation undertaken on the five sectors within the charging zone, in terms of:

- comparing PT travel costs between areas
- comparing travel costs between modes
- comparing travel times between modes.

Comparison of PT travel costs between areas

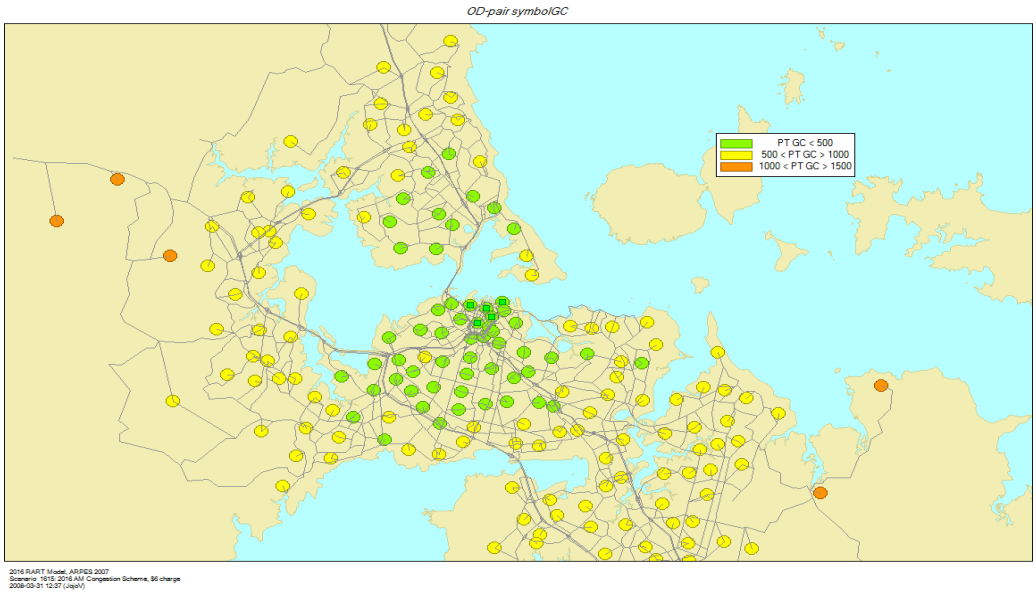
The aims of this analysis were to determine if there were any differences in the costs of passenger transport (PT) travel to each of the five sectors and to see if any zones, or clusters of zones, exhibited higher than expected costs. This would assist in identifying areas that may have a reduced level of PT services or lower levels of accessibility that could be targeted for service improvements.

The PT costs of travelling from each traffic zone in the region to each of the five sectors making up the charging area were plotted. The PT cost that is plotted is the average cost of travel by PT to the traffic zones in each sector. Given that it takes into account the time and money costs of using PT, the generalised cost is a widely-used measure of PT accessibility. The PT cost is the generalised cost (in cents) and includes fare and in-vehicle, waiting, access, egress and transfer time costs (converted to cents). Data for each sector is plotted separately (therefore there are five sector plots for each parameter assessed).

The PT costs have been plotted as dots at the origin zone of the trips, coloured according to three cost bands; those with costs less than 500 generalised cents (green), those between 500 and 1,000 (yellow), and those greater than 1,000 (orange). The average generalised costs of travel across the region in 2001 were 350 cents by car and 950 cents by PT. The first range threshold (500 cents) is roughly half the average PT cost and the second (1,000 cents) is roughly the average PT cost. The destination zones in each sector's plot are represented as green squares.

The absolute generalised cost of PT travel to each of the sectors in the charged area is shown in Figure 32, Figure 33, Figure 34, Figure 35 and Figure 36 on following pages.

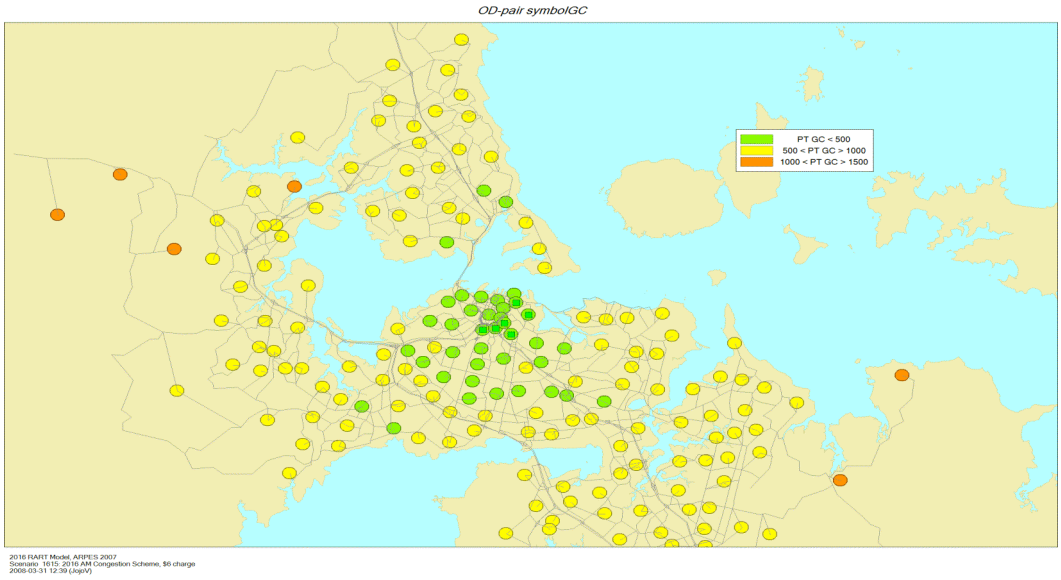
Figure 32: Sector 1 PT costs (generalised cents)



Key observations:

- Sector 1 zones are highlighted as green squares. The PT costs from each zone to Sector zones (averaged) are plotted at the origin zone as coloured dots. The colours represent ranges of costs.
- Most zones in the region can access Sector 1 at a generalised cost (GC) of less than 1,000 cents.
- Zones within about 7.5km of the CBD can access the CBD at a GC of less than 500 cents.

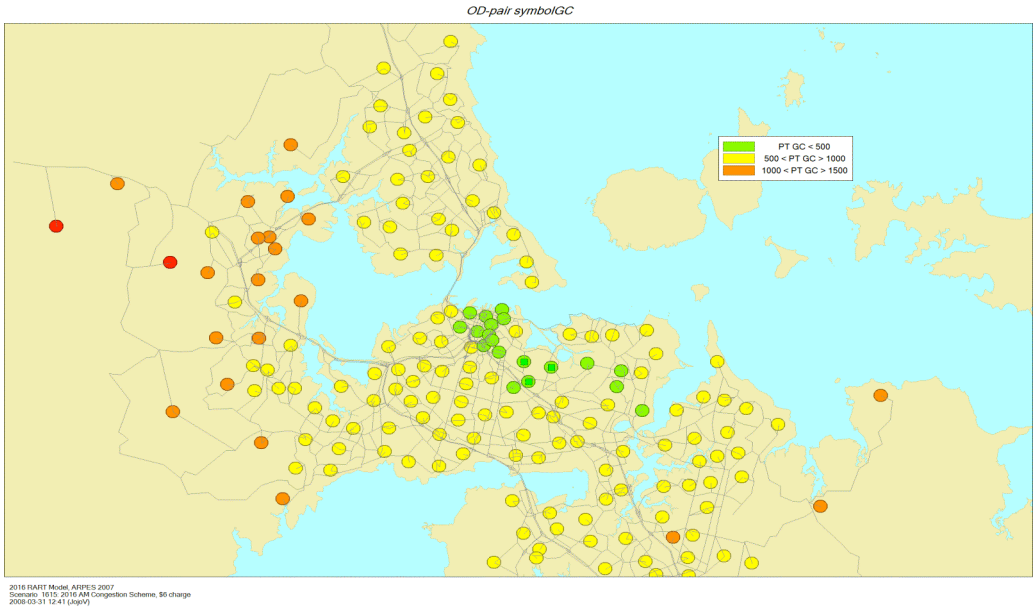
Figure 33: Sector 2 PT costs (generalised cents)



Key observations:

- Sector 2 zones are highlighted as green squares. The PT costs from each zone to Sector 2 zones (averaged) are plotted at the origin zone as coloured dots.
- Most zones in the region can access Sector 2 at a generalised cost (GC) of less than 1000: ie Sector 2 is reasonably accessible by Passenger Transport to most of the region.
- Zones within about 4km of the CBD can access the CBD at a GC of less than 500.

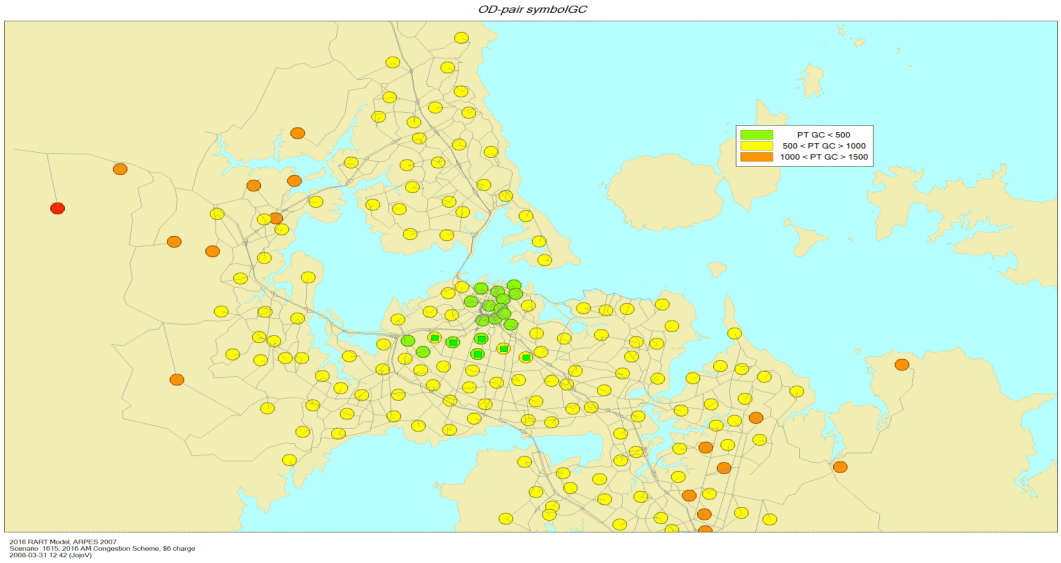
Figure 34: Sector 3 PT costs (generalised cents)



Key observations:

- Sector 3 zones are highlighted as green squares. The PT costs from each zone to Sector 3 zones (averaged) are plotted at the origin zone as coloured dots.
- Most zones in the region can access Sector 3 at a generalised cost (GC) of between 500 and 1,000.
- Only zones in the east isthmus to CBD corridor and zones in the CBD can access Sector 3 at a GC less than 500.
- One of the issues to address in this sector might be to consider improving connections across the motorway to rail, and perhaps Remuera Rd bus priority measures. However, there are, in reality, few important destinations in this sector, and not significant employment.

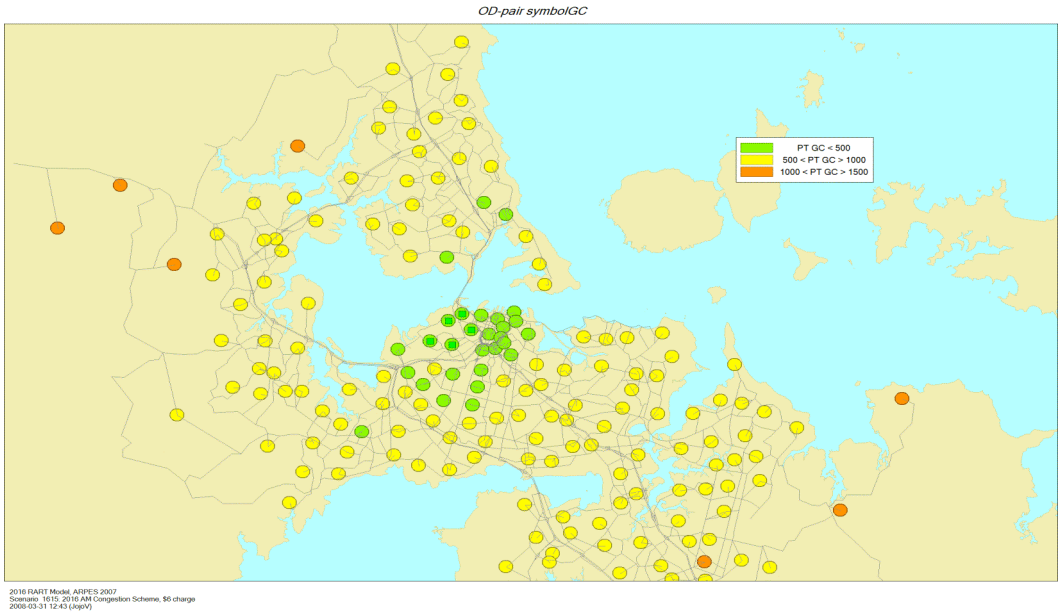
Figure 35: Sector 4 PT costs (generalised cents)



Key observations:

- Sector 4 zones are highlighted as green squares. The PT costs from each zone to Sector 4 zones (averaged) are plotted at the origin zone as coloured dots.
- Most zones in the region can access Sector 4 at a generalised cost (GC) of between 500 and 1,000.
- Only zones in Sector 4 and the CBD can access Sector 4 at a GC less than 500.

Figure 36: Sector 5 PT costs (generalised cents)



Key observations:

- Sector 5 zones are highlighted as green squares. The PT costs from each zone to Sector 5 zones (averaged) are plotted at the origin zone as coloured dots.

- Most zones in the region can access Sector 5 at a generalised cost (GC) of less than 1,000.
- Access to Sector 5 is not as good as for Sectors 1 and 2 but is better than for Sectors 3 and 4.

Comparing travel costs between modes

The aim of this analysis was to determine if there were any zones or areas where the costs of passenger transport (PT) travel were higher than for car travel. This would assist in identifying areas that may have a reduced level of PT services or lower levels of accessibility and could be targeted for service improvements. As there are likely to be zones that have low PT service levels (eg, due to low levels of demand) this data was superimposed onto the total person trip demand in each zone. This highlights zones with high relative costs and high potential demand, which can then be targeted for PT service improvements in order to mitigate the effects of the charging scheme.

The ART model was initially based on 1991 data. The ART and RART models were re-based to 2001 cost and travel data and this is the current base. All generalised travel costs (vehicle operating costs, fares, etc) use 2001 values. Values of time were derived from 2004 survey data and adjusted to 2001 levels.

The PT costs of travelling, relative to the cost of travelling by car (as a ratio), from each traffic zone in the region to each of the five sectors making up the charging area were plotted. The PT and car costs used to calculate the ratio are the average costs of travel to the traffic zones in each sector.

The car driver cost is the travel time plus the vehicle-operating cost and parking cost plus the road-pricing charge (converted to cents). Parking costs (2001 base year costs) are applied to trips ending in areas that charge for parking, including the CBD, Takapuna and Manukau CBD. The average cost paid by each car trip is applied to the car generalised cost. This cost is relatively low as only about half of the car travellers actually incur a direct parking cost, the remainder having either free parking, company parking, use of company vehicles, etc. In RART, the parking cost is applied 50/50 to the car driver and passenger, and the daily parking cost is applied to the AM peak trip (in ART the car driver pays all the parking cost). In this analysis of the Congestion Scheme a charge of $6 is added to each trip that is charged.

The PT cost that is plotted is the average cost of travel by PT to the traffic zones in each sector. PT cost is the generalised cost (in cents) and includes fare and in-vehicle, waiting, access, egress and transfer time costs (time converted to cents).

A second set of information, the total person trips starting in each zone travelling to the sector (demand), has been plotted as vertical bars (chimneys). The height of the chimney is proportional to the number of trips.

Data for each sector is plotted separately (there are five sector plots for each parameter assessed).

The PT/car travel cost ratios have been plotted as dots at the origin zone of the trips, coloured according to three cost bands:

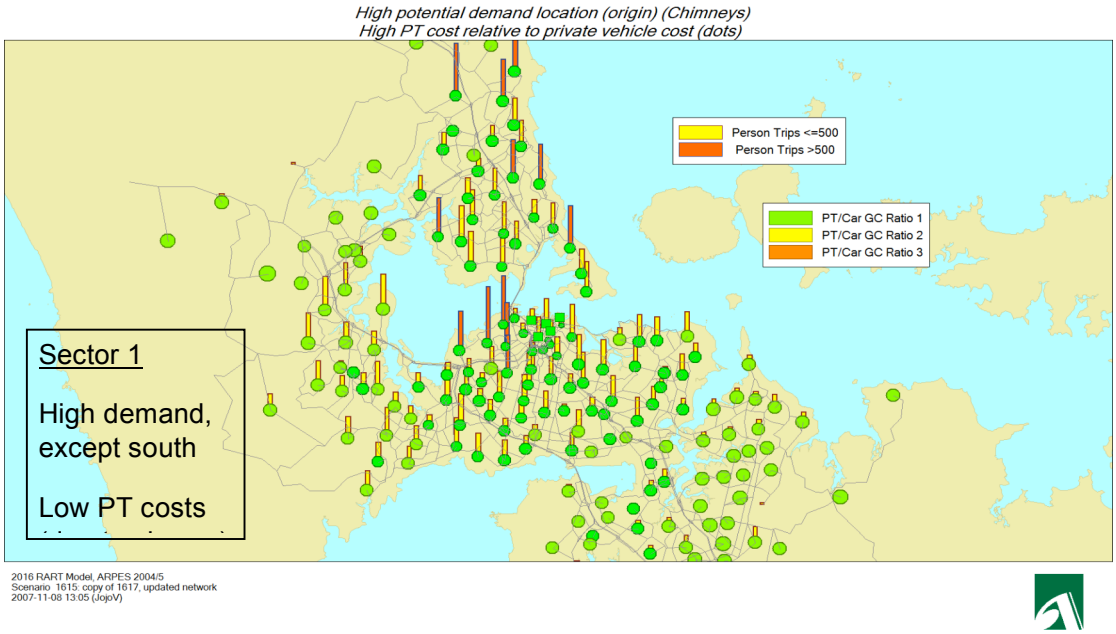
- Ratio 1 means PT costs are less than 1.5 times car costs (green)
- Ratio 2 means PT costs are between 1.5 and 2.5 times car costs (yellow)
- Ratio 3 means PT costs are more than 2.5 times car costs (orange).

The average generalised cost of travel in 2016 to regional growth centres by car and PT were 507 and 676 cents respectively. PT is 1.33 times more costly than car travel. The overall regional ratio in 2001 was 2.7 (including non-growth centres), which indicates that the proposed (2016) PTNP services improve PT costs significantly. The lower threshold ratio of 1.5 was selected as this would identify zones where it was unlikely that PT improvements would be required. The upper ratio of 2.5 was selected as this would represent 2001 PT cost levels, which indicate zones where little improvement since 2001 would be evident.

The destination zones in each sector's plot are represented as green squares.

The generalised cost of PT travel relative to car to each of the sectors in the charged area are shown in Figure 37, Figure 38, Figure 39, Figure 40 and Figure 41 below.

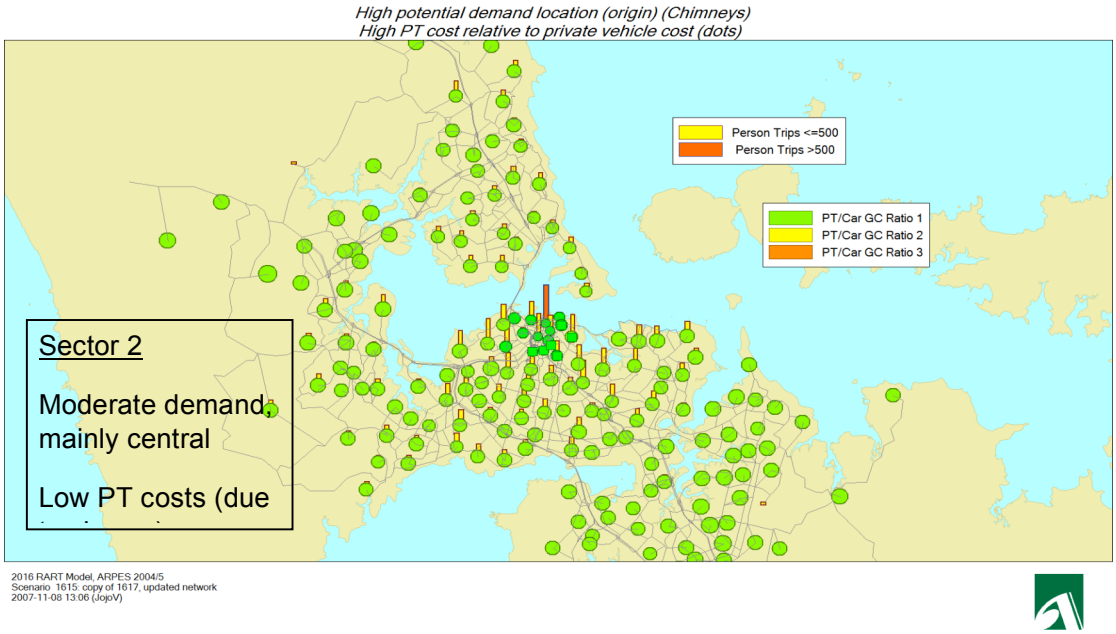
Figure 37: Sector 1 relative PT/car costs (generalised cents)



Key observations:

- Most zones in the region can access Sector 1 by PT at a generalised cost (GC) approximately the same as that of car costs (Ratio 1), mainly because of the good PT services to Sector 1 and the charge incurred by car users.
- The highest numbers of person trips to Sector 1 start in the isthmus, North Shore south and Waitakere (taller (red) chimneys).

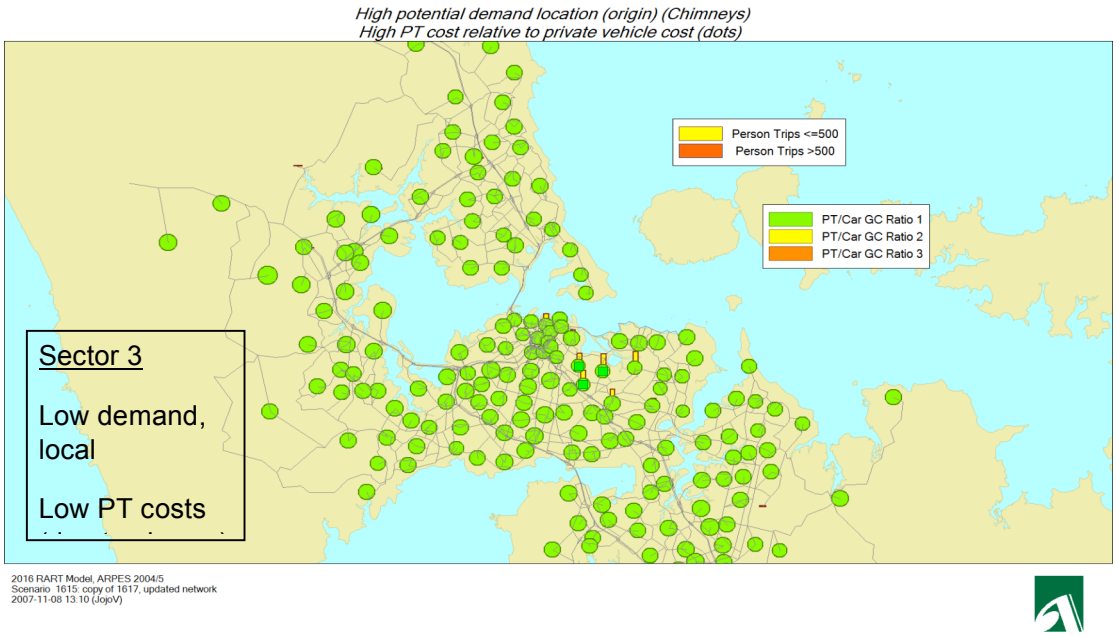
Figure 38: Sector 2 relative PT/car costs (generalised cents)



Key observations:

- Most zones in the region can access Sector 2 by PT at a generalised cost (GC) approximately the same as that of car costs (Ratio 1), mainly because of the good PT services to Sector 2 and the charge incurred by car users.
- The highest numbers of person trips to Sector 2 start in the central and east isthmus and the CBD (taller (red) chimneys).

Figure 39: Sector 3 relative PT/car costs (generalised cents)

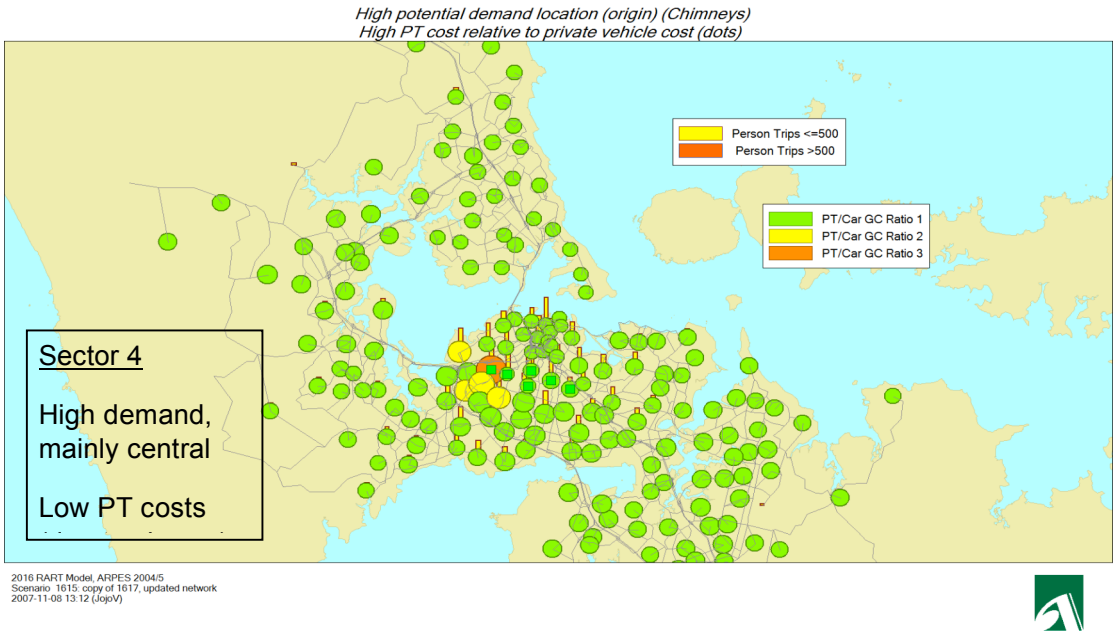


Key observations:

- Most zones in the region can access Sector 3 by PT at a generalised cost (GC) approximately the same as that of car costs (Ratio 1), mainly because of the good PT services through Sector 3 and the charge incurred by car users.

- The highest numbers of person trips to Sector 3 start in Sector 3 (taller chimneys) but overall demand is low.

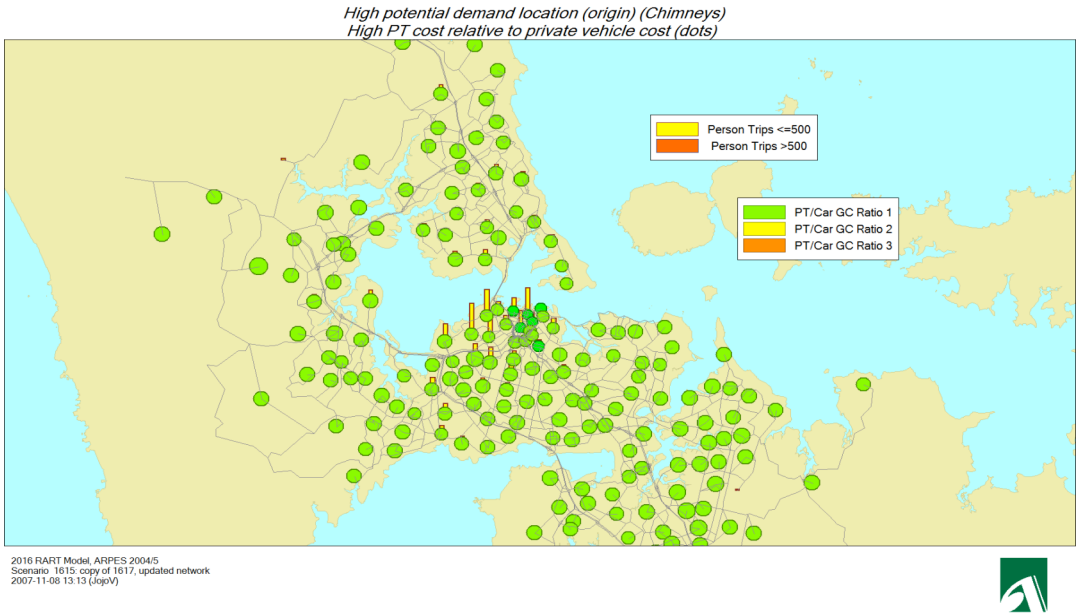
Figure 40: Sector 4 relative PT/car costs (generalised cents)



Key observations:

- Most zones in the region can access Sector 4 by PT at a generalised cost (GC) approximately the same as that of car costs (Ratio 1), mainly because of the good PT services through Sector 4 and the charge incurred by car users.
- The highest numbers of person trips to Sector 4 start in Sector 4 (taller chimneys), the CBD and the west isthmus, but overall demand is not high.
- There is a cluster of zones around the western part of Sector 4 that exhibit high relative PT costs. This is due to the PT network connections and some boundary effects at the charging area boundary generating high relative PT costs. Car costs will be low in this area. This is considered to be a network model issue rather than an accessibility issue.

Figure 41: Sector 5 relative PT/car costs (generalised cents)



Key observations:

- Most zones in the region can access Sector 5 by PT at a generalised cost (GC) approximately the same as that of car costs (Ratio 1), mainly because of the good PT services through Sector 5 and the charge incurred by car users.
- The highest numbers of person trips to Sector 5 start in the Sector 5 (taller chimneys) and the CBD but overall demand is not high.

Comparison of car and PT travel times

The aim of this analysis was to determine if there were any zones or areas where the total travel times of passenger transport (PT) travel were higher than for car travel. This would assist in identifying areas that may have a reduced level of PT services or lower levels of accessibility that could be targeted for service improvements. As there are likely to be zones that have low PT service levels (eg because of low levels of demand) this data was superimposed onto the total person trip- demand in each zone. This highlights zones with high relative travel times and high potential demand, which can then be targeted for PT service improvements in order to mitigate the effects of the charging scheme.

The PT travel time, relative to the travel time by car (as a ratio) from each traffic zone in the region to each of the five sectors making up the charging area, was plotted. The PT and car travel times used to calculate the ratio are the average travel times to all the traffic zones in each sector.

The car travel time is the zone-to-zone travel time in minutes. We have used the travel time for cars in the non-priced environment, to better illustrate the trade-off that current car users would face in moving from car to PT in the Congestion Scheme.

The PT travel time includes in-vehicle, waiting, access, egress and transfer time costs.

A second set of information, the total person trips starting in each zone travelling to the sector (demand), has been plotted as vertical bars (chimneys). The height of the chimney is proportional to the number of trips.

Data for each sector is plotted separately (there are five sector plots for each parameter assessed).

The PT/car travel time ratios have been plotted as dots at the origin zone of the trips, coloured according to four cost bands:

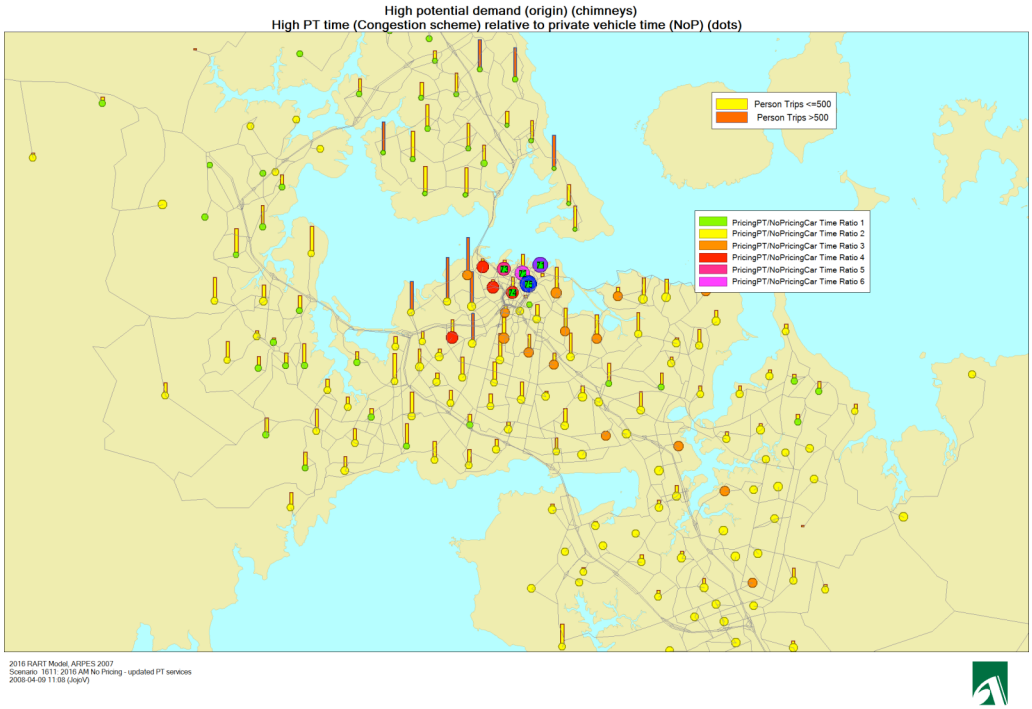
- Ratio 1 means PT travel times are less than 1.5 times car travel times (green)
- Ratio 2 means PT travel times are between 1.5 and 2.5 times car travel times (yellow)
- Ratio 3 means PT travel times are between 2.5 and 3.5 times car travel times (orange)
- Ratio 4 means PT travel times are more than 3.5 times car travel times (red).

The average travel times in 2016 to regional growth centres by car and PT were 18.0 and 49.6 minutes respectively. Average PT journey times are 2.7 times longer than car travel times. The overall regional ratio in 2001 was 4.3 (including non-growth centres). The lower threshold ratio of 1.5 was selected, as this would identify zones where it was unlikely that PT improvements would be required. The upper ratio of 3.5 was selected, as this would represent 2001 PT travel time levels, which indicate zones where little improvement since 2001 would be evident.

The destination zones in each sector's plot are represented as green squares.

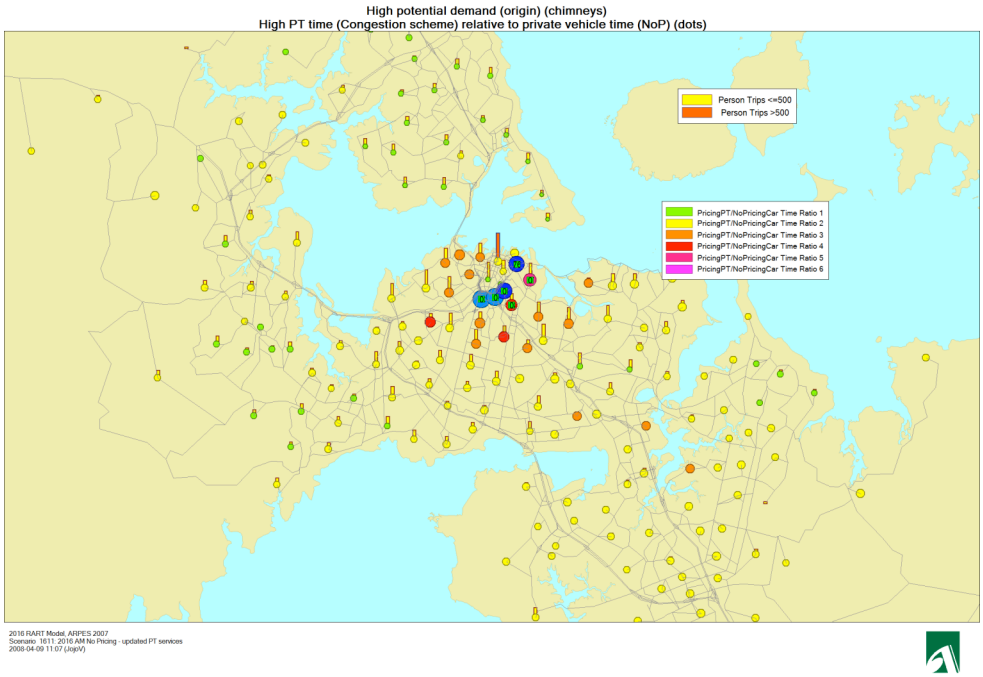
The ratios of PT travel times relative to car to each of the sectors in the charged area are shown in Figure 42, Figure 43, Figure 44, Figure 45, and Figure 46 below. The figures show that, based on the modelled outcomes, PT is slower than using the private car, particularly on short-distance trips because modelled car travel times do not have access, egress, wait or transfer time components (which, for instance, means there is no allowance for those who do not have a parking space at their destination). Longer-distance trips result in PT times becoming more competitive.

Figure 42: Sector 1 relative PT (congestion)/car ('no-pricing') travel times (minutes)



- Key observations (when PT times are compared with the non-priced 2016 network):
- Many zones in the region (particularly longer trips from the north and the west of the region) can access Sector 1 at approximately the same travel time as private car (Ratio 1). Most zones in the region can access Sector 1 by PT at a travel time approximately twice that of a car (Ratio 2).
- Zones close to Sector 1 can be accessed by car very quickly relative to PT, reflecting poor PT/car time ratios. These zones potentially provide more of an opportunity for walking or cycling than PT.
- Most person trips to Sector 1 start in the isthmus, North Shore south and Waitakere (taller (red) chimneys).

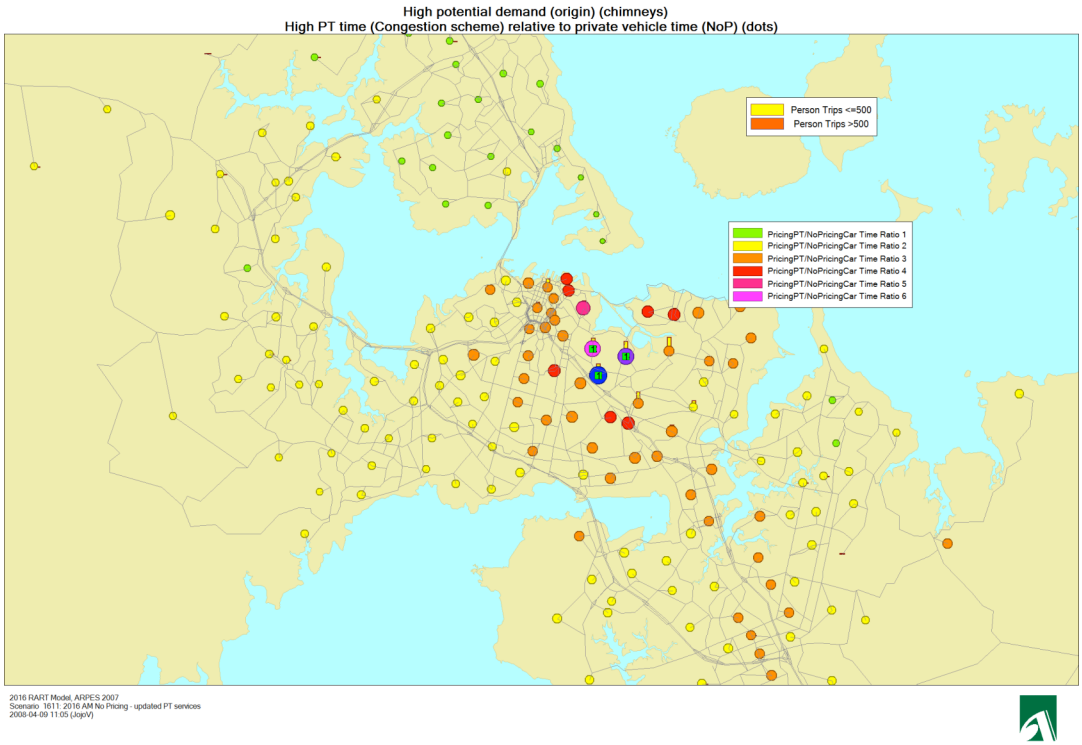
Figure 43: Sector 2 relative PT (congestion)/car ('no-pricing') travel times (minutes)



Key observations (when PT times are compared with the non-priced 2016 network):

- A number of zones in the north and west of the region can reach Sector 2 at a travel time approximately the same as that of a car on the non-charged 2016 network. Most zones in the region can access Sector 2 by PT at a travel time approximately twice that of a car (Ratio 2).
- Zones close to Sector 1 can be accessed by car very quickly relative to PT, reflecting poor PT/car time ratios. These zones potentially provide more of an opportunity for walking or cycling than PT.
- Sector 2 is less accessible than Sector 1 (CBD) by zones in the central isthmus.
- Most person trips to Sector 2 start in the isthmus and the CBD (taller (red) chimneys).

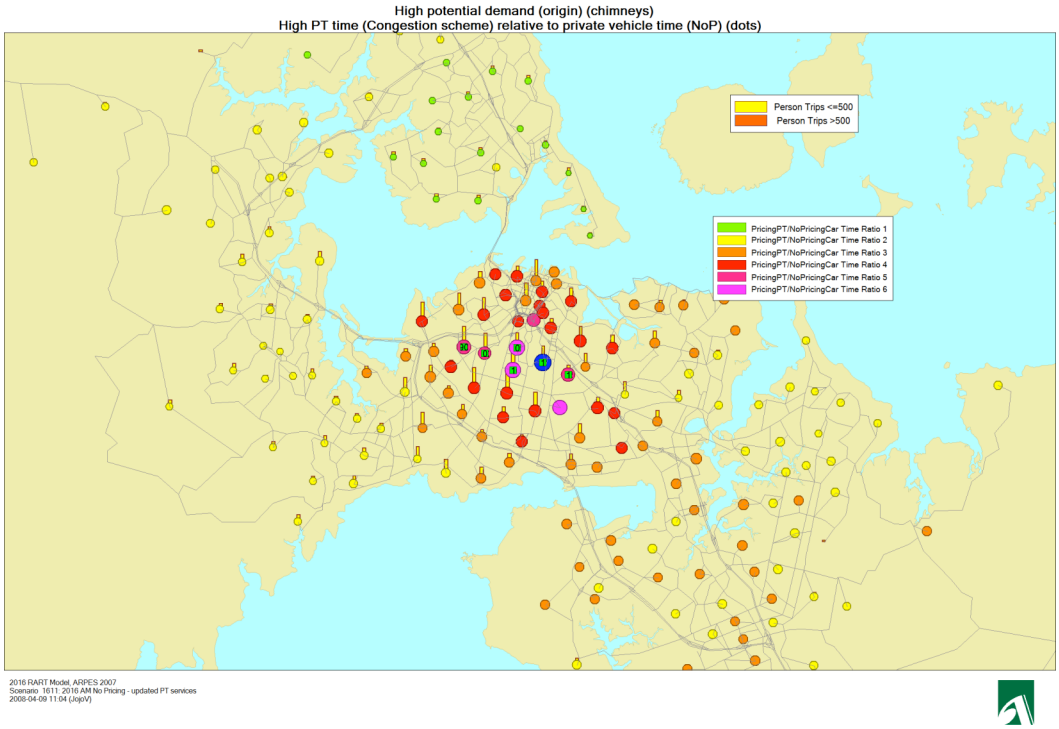
Figure 44: Sector 3 relative PT (congestion)/car ('no-pricing') travel times (minutes)



Key observations (when PT times are compared with the non-priced 2016 network):

- Some zones in the north of the region can reach Sector 2 at a travel time approximately the same as that as a car on the non-charged 2016 network. Most zones in the region can access Sector 3 by PT at a travel time approximately twice that of car times (Ratio 2).
- Zones close to Sector 3 can be accessed by car very quickly relative to PT, reflecting poor PT/car time ratios. These zones potentially provide more of an opportunity for walking or cycling than PT.
- Sector 3 is less accessible than Sectors 1 (CBD) and 2 by zones in the central Isthmus and towards the south.

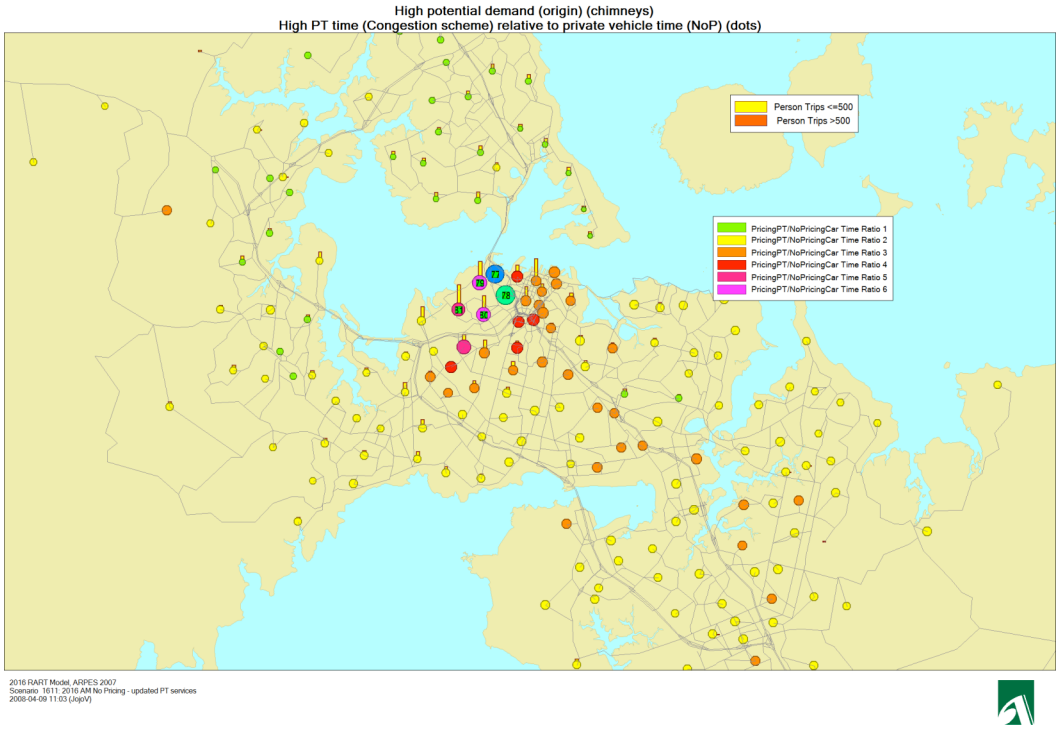
Figure 45: Sector 4 relative PT (congestion)/car ('no-pricing') travel times (minutes)



Key observations (when PT times are compared with the non-priced 2016 network):

- Some zones in the north of the region can reach Sector 2 at a travel time approximately the same as that of a car on the non-charged 2016 network. Most zones in the region can access Sector 4 by PT at a travel time approximately two to three times that of a car (Ratios 2 and 3). There are, however, more zones that face significantly higher travel times for PT.
- Zones close to Sector 4 can be accessed by car very quickly relative to PT, reflecting poor PT/car time ratios. These zones potentially provide more of an opportunity for walking or cycling than PT.
- Sector 4 is less accessible than Sectors 1 (CBD) and 2 by zones in the central isthmus and towards the south.

Figure 46: Sector 5 relative PT (congestion)/car ('no-pricing') travel times (minutes)



Key observations (when PT times are compared with the non-priced 2016 network):

- Some zones in the north of the region can reach Sector 2 at a travel time approximately the same as that of a car on the non-charged 2016 network. Most zones in the region can access Sector 5 by PT at a travel time approximately twice that of a car (Ratio 2).
- Zones close to Sector 5 can be accessed by car very quickly relative to PT, reflecting poor PT/car time ratios. These zones potentially provide more of an opportunity for walking or cycling than PT.
- Sector 5 is less accessible than Sectors 1 (CBD) and 2 by zones in the central isthmus and towards the south.

Improving relative travel times

Should a scheme be adopted, the analysis above has shown that the main focus would need to be on improving relative travel times of car and public transport trips. The structure of the PTNP, with RTN, QTN and LCN components, would be unlikely to require significant revision, but any marginal re-design would focus on:

- reducing interchange time
- higher quality interchange
- reducing wait time
- providing more certainty around inter-connecting services.

The main initiative, rather than re-design of the network, would be to provide additional services, making significantly more use of bus priority measures and ensuring that the planned introduction of integrated fares and ticketing is delivered.

Passenger transport capacity

The passenger transport (PT) capacity assessment was carried out to determine if (and if so, where) PT demand exceeded capacity. This would determine whether additional services would be required to meet the increased PT demand resulting from the implementation of the charging scheme.

This is a broad-based assessment and does not assess individual PT services. Note that it covers the peak AM 2-hour period and does not model peaks within this period. The changes between the 'no-pricing' and charging options are therefore the principal interest.

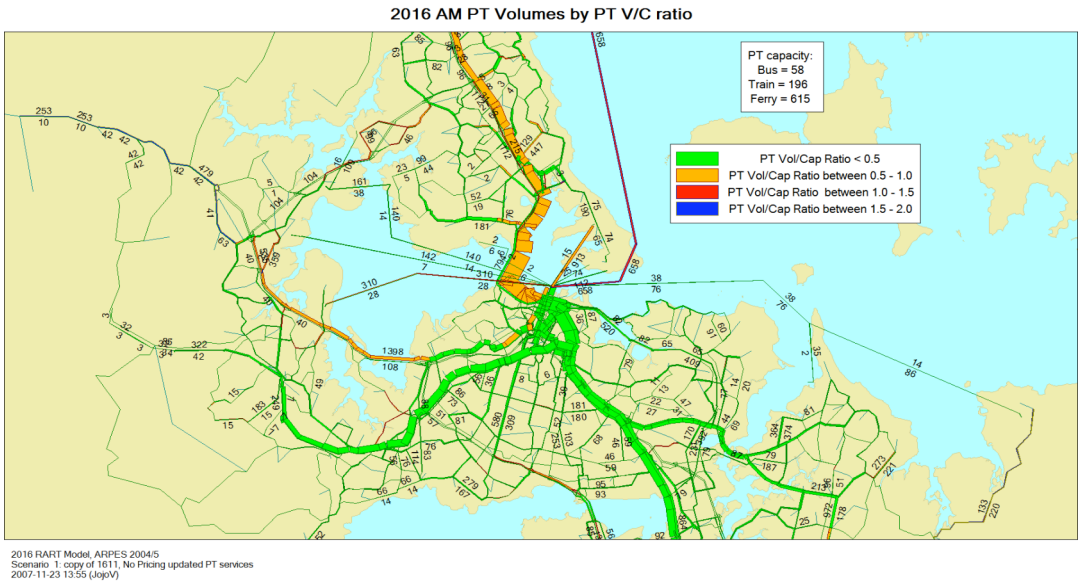
PT capacity by vehicle type was multiplied by the number of services to estimate the capacity available on each PT link over the morning peak two-hour period (passengers, 2016, 7-9 am). The passenger demand was divided by the PT capacity to obtain a volume / capacity (V/C) ratio. A volume / capacity ratio of less than 1.0 indicates that there is spare capacity, a value greater than 1.0 indicates that the link operates over capacity (ie demand exceeds supply).

Note that the PTNP network developed by ARTA included an assessment of under-serviced areas, total passenger demand and route design. The ARTA analysis used the Auckland Passenger Transport model (APT) which, although deriving data from the ART model, is a more accurate representation of PT services and demands than the ART model. It is expected that the ARTA analysis adequately addresses these issues and appropriately matches supply to demand.

Figure 47 and Figure 48 depict the PT volume / capacity ratios of the 'no-pricing' and Congestion Schemes respectively (the Congestion and Revenue Schemes exhibit similar results). The volume / capacity ratios are coloured into four bands according to severity:

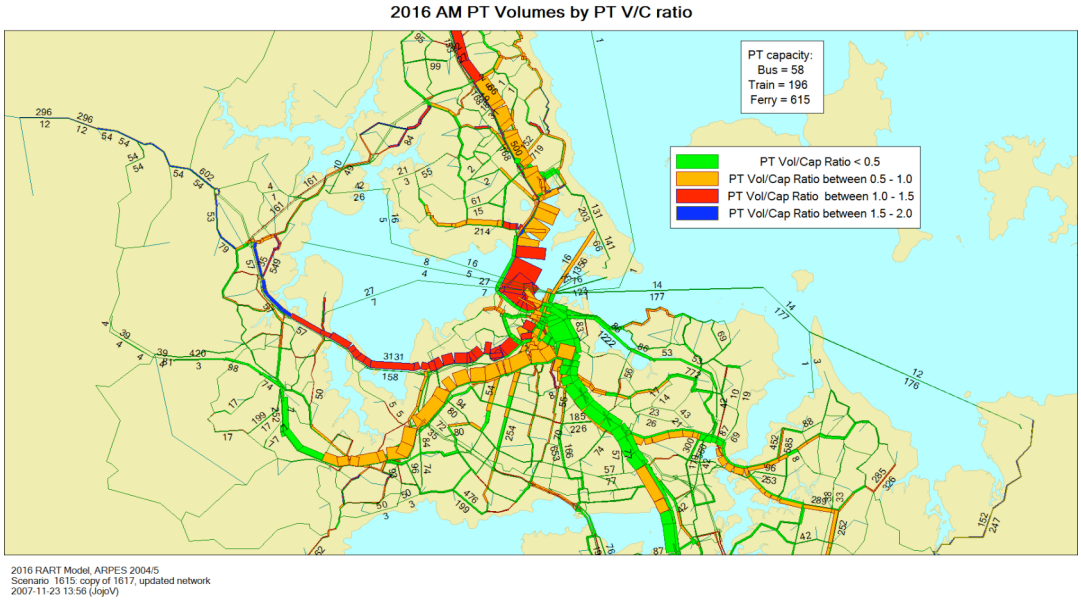
- PT volume / capacity ratios less than 0.5 – light loading (green)
- PT volume / capacity ratios between 0.5 and 1.0 – up to capacity (orange)
- PT volume / capacity ratios between 1.0 and 1.5 – demand exceeds capacity (red)
- PT volume / capacity ratios more than 1.5 – very high demand relative to capacity (blue).

Figure 47: PT volume / capacity analysis – 'no-pricing'



Under the 'no-pricing' option there are a few over-capacity links (red or blue) on the outskirts of the region. ARTA monitors issues of over capacity using the real time information system and has operational procedures in place to address these issues.

Figure 48: PT volume / capacity analysis – Congestion Scheme



The increased PT demand due to pricing, increases the demand on the PT network. Revenue generated from the pricing scheme could be used to enhance service capacity for these areas.

There are capacity problems along the Harbour Bridge and SH16 (to the CBD) (red and blue lines) which would also need to be addressed.

Passenger transport mitigation

Building from the capacity analysis above, an assessment of the level of passenger transport service increases required to mitigate the effects of charging was carried out using the RART model. This was a broad, high-level assessment aimed at obtaining an indication of investment required to cater for trips that divert from car to PT once charging is implemented. As noted above, the PTNP process addressed these issues but excluded the effects of charging, so no significant improvements are anticipated, compared to those identified in the ARPES study, which was based on previous PT network designs.

A number of broad, simple methods were tested to determine the level of PT service increase required to accommodate the additional PT demand. A simplified method for estimating the extent of additional PT services for mitigating the effects of charging was required for this stage of the project. In the detailed design stages the full PT service design could be considered for amendment (although, as noted previously, it appears that the PTNP network structure would remain robust in a priced environment similar to that presented by the Congestion Scheme.

Only over-capacity services need to be improved, not those operating under capacity.

Method 1: 100% V/C threshold

Method 1: the number of over-capacity PT service kilometres of travel in the 'no-pricing' and Congestion Scheme options were compared. The difference (as a percentage) is an estimate of the scale of mitigation required.

No Pricing: PT km > 1.0 V/C km / Total PT km

= 242/32,209 = 0.75%

Congestion: PT km >1.0 V/C km / Total PT km

= 1040/32,209 = 3.23%

% increase = 3.23% - 0.75% = 2.48%

>> increase PT services by 2.48%

Method 2: 80% V/C threshold to allow for improved service levels

Method 2: as for Method 1 but a lower threshold of 80%, rather than 100%, of capacity was used to reflect improved levels of PT service.

No Pricing: PT km >1.0 / Total PT km

= 348/32,209 = 1.085%

Congestion: PT km >1.0 / Total PT km

= 1577/32,209 = 4.29%

% increase = 4.9% - 1.08% = 3.8%

>> increase PT services by 3.8%

Method 3: Average loading factor on PT services

The average load factors (ratio of passengers to capacity) for the full PT network in the 'no-pricing' and Congestion options were compared. The difference would reflect what scale of PT services would need to be added to retain the 'no-pricing' levels. This method is non-specific and is expected to yield a high level of mitigation.

'No-pricing' global = 0.30

Congestion global = 0.44

Therefore 30% increase in services to revert to 0.30 load factor.

Can investigate possibility of reducing inefficient services and moving them to routes with high loading factors to reduce required service increase.

Method 4: Average loading factor on congested route

Method 4: Assess over-loading of congested routes in isolation.

- Harbour Bridge route is only just over capacity (ignore)
- Northwestern Motorway PT V/C = 1.5

Therefore 50% increase on this corridor, or about 1,500km service kilometres out of 32,209 km. This route would require an additional 4.6% of capacity to be added to the regional PT network.

Summary

It is recommended that, at this stage, the best methods to apply are either method 1 or 2, particularly given that the congested section of the PT network is restricted mainly to Northwestern Motorway (V/C approx 1.5) and Harbour Bridge (V/C approx 1.04).

This broad assessment indicates that the PT mitigation would require approximately 5% more service kilometres than the current PTNP services. Note that the current PTNP services can be funded under the prevailing funding system. Any additional services cannot be funded without additional funding being provided.

It should also be noted that this conclusion is based on the RART model which is a high-level strategic model and not a detailed passenger-transport model. Therefore, this conclusion must be seen as indicative and should the road-pricing initiative proceed, would have to be reviewed using more detailed and accurate methods.