Table 3 Summary of Mitigation Strategy Proposals

Action	Single Cordon	Double Cordon	Area	Strategic Network	Parking Levy
Public Transport Improvements	Integrated fares, increased rail and bus frequencies across cordon, extensive new cross-town bus services and bus lanes. Demand-responsive public transport services for travel from outside cordon to locations poorly served by fixed routes.	Integrated fares, increased rail and bus frequencies across cordon, extensive new cross-town bus services and bus lanes. Demand-responsive public transport services for travel from outside outer cordon to locations poorly served by fixed routes.	Integrated fares, increased rail and bus frequencies into area, additional cross-area bus services and bus lanes.	Integrated fares, increased rail and bus frequencies on parallel corridors, increased bus lanes.	Integrated fares, increased bus frequencies on routes to parking zones, and selected additional services to Newmarket, Manukau and Henderson.
Roading Improvements	None	Improvements to capacity of inner cordon boundary route (detail not yet developed).	Improvements to capacity of area boundary route (detail not yet developed).	Improvements to capacity of arterial routes likely, but not yet developed.	None
Traffic & Parking Management	None	Traffic management on and around inner cordon boundary route to control "rat-running" (detail not yet developed).	Traffic management on and around boundary route to control "rat-running" (detail not yet developed).	Traffic management on and around local arterial routes to control rat running likely, but not yet developed.	Resident-only parking schemes and on-street parking controls in areas surrounding parking zones.
Walk and Cycle Improvements	Pedestrian improvements in New Lynn/Avondale, and cycling lanes to facilitate cross-boundary travel.	Pedestrian improvements in New Lynn/Avondale, and across/inside the inner cordon boundary, and cycling lanes to facilitate cross-boundary travel.	Pedestrian and cycle facility improvements into and within the area.	Safety facilities and improvements on local arterials to reduce conflict from diverted traffic.	Pedestrian improvements in and around parking zones to assist park and walk activity.
Exemptions	None	None	None	None	Residents in parking zone.
Compensation to Key Groups	Vouchers for selected disabled, health, specialist education, transition to work and volunteers.				

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Part C: Impact Assessment Results

Traffic and Transport Impact Results

95. The summary traffic modelling results show:

- **Base Case (Unpriced 2016 network):** Despite significant investment in roading and public transport, widespread congestion on motorways, in the Auckland CBD and on a range of critical local roads. **Overall, 20% congested vehicle kilometres travelled (VKT[9]).**
- **Single Cordon scheme:** Very effective at reducing congestion on motorways that cross the cordon due to the lack of alternative routes. Reasonably effective at reducing congestion on local roads inside the cordon due to fewer vehicles crossing the cordon. 135,000 vehicle trips would cross the cordon without pricing and these are reduced by 23% in a priced environment, with 77% continuing to cross the cordon and pay the charge. **Overall, 14% congested VKT.**
- **Double Cordon scheme:** The Double Cordon is more effective than the Single Cordon at reducing congestion on most motorways that cross the cordons. It is also reasonably effective at reducing congestion on local roads inside the cordon boundaries, however, there is some diversion around the perimeter of both cordons. 183,000 vehicle trips would cross either cordon (or both) without pricing, and these are reduced by 36% in a priced environment, with 64% paying a charge. **Overall, 12% congested VKT.**
- **Area scheme**: Effective at reducing congestion on local roads inside the boundary and on motorways leading into the Area; however, increases congestion on perimeter roads. 217,000 vehicle trips would occur in the Area scheme without pricing and these are reduced by 42% in a priced environment, with 58% paying the charge. **Overall, 14% congested VKT.**
- **Strategic Network Charging scheme**: Very effective at relieving congestion on motorways, but increases congestion on the local road network. 199,000 vehicle trips would use the Strategic Network without pricing and these are reduced by 20% in a priced environment, with 80% paying a charge. **Overall, 15% congested VKT on the motorway network.**
- **Parking Levy scheme**: Minor reductions in congestion across Auckland isthmus area. 47,000 vehicle trips would terminate in the Parking Levy zones without pricing. These are reduced by 47% in a priced environment, with 53% paying the levy. **Overall, 18% congested VKT.** These results are based on the assumption that approximately 50% of motorists would face the charge directly, i.e. it would not be paid for them by their employer or the car park owner.

[9] The percentage of the total distance travelled by vehicles over the wider Auckland roading network (as defined by the RART model) during the morning peak period on congested roads is known as the % of congested VKT.

Mode Shares and Vehicle Trip Suppression

96. Presented below is daily mode share data from the RART model (7-9AM morning peak, 2016 across the whole network).

Table 4 Mode Shares

Mode	No Pricing	Single Cordon	Double Cordon	Area	Strategic Network	Parking Levy
Total nominal trips/day (000s)	**752**	**754**	**751**	**740**	**749**	**754**
Number of vehicle trips (000s)	446	437	426	409	437	432
% vehicle (driver) trips	*59%*	*58%*	*57%*	*55%*	*58%*	*57%*
Number of passenger trips (000s)	103	101	99	95	103	99
% vehicle passengers trips	*14%*	*13.5%*	*13%*	*13%*	*14%*	*13%*
Number of walk/cycle trips (000s)	120	120	121	130	120	121
% walk / cycle trips	*16%*	*16%*	*16%*	*18%*	*16%*	*16%*
Number of PT trips (000s)	83	96	105	106	89	102
% passenger transport trips	*11%*	*13%*	*14%*	*14%*	*12%*	*14%*

97. This shows that in all cases motor vehicle trips reduce and other modes increase. In particular:

- The Single Cordon and Double Cordon schemes overall show modest decreases in car driver trips. In fact, more vehicle trips are eliminated for in each scheme than the net figures portray, especially trips originating outside the outer cordon. These are, however, offset to a significant degree by increases in vehicle activity both inside and outside the cordons as drivers take advantage of reduced congestion.
- The Area scheme is the most effective at reducing net vehicle trips (-8%) and overall net person trips (-2%). This scheme shows a substantial increase in walk/cycle trips (+8%), probably reflecting the focus on charging inside a relatively small zone. Passenger transport trips also increase significantly (+28%).
- The Strategic Network Charging scheme does not reduce vehicle trips as much as the Area scheme (-2% overall). This suggests that vehicle trips impacted under this scheme are less likely to switch to alternative modes, but rather choose an alternative route.
- The Parking Levy scheme focuses on terminating commuter trips into the CBDs. These trips have very limited diversion options (either by destination or time) and therefore this scheme significantly affects the mode of travel but barely affects the number of trips made.

98. It is useful to examine the absolute trip reduction levels across the five schemes to determine their relative effectiveness in reducing congestion across the region's entire road network.

Table 5 Vehicle Trip Suppression Rates

Mode	Single Cordon	Double Cordon	Area	Strategic Network	Parking Levy
Net vehicle trip suppression (000s)	-9	-20	-37	-9	-14
Gross vehicle trip suppression (000s)	-21	-32.5	-41.5	-7	-12
% vehicle suppression	*-5%*	*-7%*	*-9%*	*-2%*	*-3%*

99. The Area and Double Cordon schemes significantly reduce the overall number of vehicle trips and road users should experience improved levels of service across significant parts of the network. The Single Cordon scheme also reduces vehicle trips. Both the Single and Double Cordon also act

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to increase vehicle trips in some parts of the network – probably in response to reduced congestion. The advantage of the Single Cordon scheme over the Double Cordon and Area schemes (from a purely congestion perspective) is that the natural geographic boundary constraints prevent any diversion onto uncharged alternative routes.

100. The Strategic Network Charging and Parking Levy schemes show only modest levels of trip suppression. However, trip suppression on the charged network would be very noticeable.

101. Analysis of travel times to major commercial vehicle (CV) destinations (e.g. port, airport and East Tamaki) shows that:

- The Double and Single Cordon schemes significantly reduce travel times to all these destinations. The Area scheme increases travel times, primarily due to high usage by freight vehicles of the Area scheme perimeter route, which becomes more congested. The Strategic Network Charging and Parking Levy schemes do not significantly affect travel times to these locations.
- The increases in travel times to the airport shown under the Area, Strategic Network and Parking Levy schemes are a result of destination changes outside the charged zones affecting traffic flows in south Auckland. However, these changes in trip-making behaviour do not significantly increase congestion across south Auckland and the trip time impact on freight vehicles is less than 1 minute on average (0.19 min-0.82 min).

102. Table 6 provides a comparative analysis of each scheme against performance indicators considered most relevant to congestion management.

103. The Double Cordon scheme provides the greatest congestion reduction benefit, while the Single Cordon and Area schemes are the next most effective, followed by the Parking Levy and Strategic Network schemes. Although this study has not measured trip time reliability, a less congested network is better able to deal with network incidents such as crashes.

Table 6 Summary of Traffic and Transport Impact Results

Scheme	Total VKT/Average Trip Length	Total Vehicle Trips per day	% VKT on Congested Roads	Average Travel Speeds (entire network)	Average Travel Speeds (Isthmus/North/ West)	Average Vehicle Travel Trip Times	Average PT Travel Time[10] & Trips Made (000's)
No Pricing	4.5m / 10.2 km	446,000	20%	39.5 km/hr	39 / 37 / 38 km/hr	15 mins	70 mins / 84 trips
Single Cordon	4.2m / 9.7 km	437,000 (-9,000/2%)	14%	44 km/hr	42 / 48 / 44 km/hr	13 mins	54 mins / 99 trips
Double Cordon	4.1m / 9.6 km	426,000 (-20,000/4%)	12%	44 km/hr	41 / 48 / 49 km/hr	13 mins	52 mins / 108 trips
Area	4.2m /10.2 km	409,000 (-37,000/8%)	14%	43 km/hr	41 / 47 / 44 km/hr	14 mins	53 mins / 107 trips
Strategic Network	4.3m / 9.8 km	437,000 (-9,000/2%)	15%	40 km/hr	36 / 41 / 43 km/hr	15 mins	62 mins / 91 trips
Parking Levy	4.4m / 10.2 km	432,000 (-14,000/3%)	18%	42 km/hr	40 / 42 / 41 km/hr	15 mins	54 mins / 102 trips
Overall	Drivers tend to travel less to minimise charges. Trip lengths also tend to reduce, particularly for schemes focused on longer trips (Cordon schemes, Strategic Network), although the diversion effect works to offset this for the Area and SN schemes.	In most cases, trip reductions in some parts of the network are offset by increases in other parts of the network – either due to diversion, or due to release of suppressed demand as congestion reduces. This offsetting effect is particularly obvious for the Single Cordon where trips inside the cordon increase by 5%.	Some schemes (in particular Strategic Network, but also Area) reduce congestion in some places and increase in others. Double Cordon most effective due to higher average charge/trip (capped at $6 vs $5 for Area and $3 for Single Cordon, except on AHB)	Average speeds increase across most roads, but in Strategic Network speeds reduce significantly on local roads and this largely offsets the speed gains on the motorways averaged across the whole network.	All schemes show good speed gains from the north and west, although the SN and Parking gains are more modest (SN, due to lower charges on AHB, Parking due to fewer trips impacted). On Isthmus, speed gains more modest, and actually reduce for SN.	Trip times reduce for the Area and Cordon schemes but are largely unchanged for Strategic Network and Parking Levy schemes.	Improvements in PT times/trips are significantly affected by the proposed mitigation measures which increase PT frequency/capacity (highest for Cordon schemes). PT travel times also affected by congestion reductions in the CBD. This is highest for Double Cordon, Area and Parking Levy schemes.

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[10] Average PT travel times are also significantly influenced by the distribution of the trips taken by PT users. The Parking Levy and Area schemes are effective at encouraging PT mode shift for shorter trips, e.g. within the Area scheme boundary, or from the edges of the Parking scheme zones.

Financial Evaluation

104. The table below provides an overview of the financial results for each scheme. The analysis has been carried out using a 20-year time horizon on the assumption that road pricing policies and technologies are likely to have significantly advanced within this period.

Table 7 Summary of Financial Evaluation Results

Scheme	Single Cordon	Double Cordon	Area	Strategic Network	Parking Levy
Total daily trips charged (2016)	103,407	116,969	97,138	159,437	25,127
Nominal average charge per car trip [Ø] in 2016	$4.31	$5.01	$6.22	$1.77	$12.43
Nominal average charge per CV trip [Ø] in 2016	$4.31	$5.21	$6.22	$2.26	N/A
Financial Outcomes (20 yrs)					
Revenues*	$m	$m	$m	$m	$m
Year 1 Scheme Gross Revenue (nominal)	110.9m	143.1m	137.2m	85.9m	76.2m
NPV^ of Total Operating Revenues	1,006.6m	1,293.5m	1,283.8m	911.4m	713.5m
Scheme Operating Costs					
Year 1 Scheme Gross Operating Costs (nominal)	52.5m	61.5m	52.0m	65.0m	29.6m
NPV of Total Opex	422.5m	495.3m	435.7m	591.8m	259.5m
Scheme Capital Expenditure					
Nominal Initial Capex (debt funded)	58.1m	71.1m	74.8m	63.2m	12.0m
Nominal Refreshment Capex	151.1m	165.6m	169.7m	178.4m	13.0m
NPV of Refreshment Capex	38.4m	40.5m	41.1m	44.8m	2.6m
Funding Costs					
Year 1 Scheme Net Interest (nominal)	(6.6m)	(8.1m)	(8.5m)	(7.2m)	(1.4m)
NPV of Interest Received	31.7m	44.4m	47.2m	14.6m	27.5m
NPV of Debt Repayments	(38.3m)	(46.9m)	(49.4m)	(41.7m)	(7.9m)
Pre-Mitigation NPV of All Scheme Revenues and Costs (discounted to 1/1/2006)					
Overall NPV Result Excluding Mitigation Costs	**539.0m**	**755.2m**	**804.8m**	**247.7m**	**470.9m**
Mitigation Costs					
Year 1 Gross Mitigation Opex (nominal)	61.7m	55.0m	39.3m	38.1m	(4.5m)
NPV of Mitigation Opex	515.2m	459.1m	328.0m	318.5m	(38.0m)
NPV of Mitigation Capex and Funding Costs	(115.9m)	(146.5m)	(127.0m)	(185.9m)	(48.1m)
Scheme Post-Mitigation Cash Flows (discounted to 1/1/2006)					
NPV of All Post-Mitigation Revenues and Costs	**(92.1 m)**	**149.6 m**	**349.9 m**	**(256.7 m)**	**460.8 m**

[Ø] Note that the average charge per trip is calculated after taking account of the daily cap for each scheme

* Net of revenue leakage factors such as unreadable number plates, untraceable owners, etc

^ All NPV values discounted at 8%

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105. The financial evaluation results can be summarised as follows:

- The Single Cordon scheme produces moderate revenue cash flows, around 30% lower Net Present Value (NPV) than the Double Cordon and Area schemes. Mitigation operating costs for the Single Cordon are the highest of the schemes examined due to the nature of the social impacts (see below) and consequently the proposal for reasonably extensive enhancements to public transport provision to ensure access and mobility are not significantly compromised by the implementation of this scheme.
- The Double Cordon scheme is driven by relatively high traffic volumes and solid margins, producing strong revenue cash flows. However, the Double Cordon scheme has higher capital costs due to the need for around three times the toll gantries required for the Single Cordon. Capital costs related to mitigation are higher than the Single Cordon scheme as there are a range of traffic diversion impacts to be managed.
- The Area scheme generates the highest net operating cash flows of any scheme. Margins benefit from moderate operating costs and capital expenditure requirements compared to strong revenue flows. Mitigation operating costs for the Area scheme are relatively low as the social impacts are not as significant, but capital expenditure related to mitigation is higher as there is a range of traffic diversion impacts to be managed primarily through road capacity enhancements at the Area perimeter.
- The Strategic Network Charging scheme produces the smallest net operating cash flows; despite very high transaction volumes, the small margin achieved on each trip means that there is little cash flow available for debt financing and mitigation. This scheme faces moderate scheme-related capital expenditure costs due to the need to install toll gantries at entry/exit points along the tolled network. Capital costs related to mitigation are high as there is a range of traffic diversion impacts to be managed primarily through local road capacity enhancements.
- The Parking Levy scheme generates the lowest revenues of the schemes examined, but benefits from lower operating costs and capital expenditure requirements than the other schemes. The Parking Levy scheme does not generate significant adverse social impacts and hence the mitigation costs are low as well.

Auckland Business Sector Impact Assessment

106. The study has analysed the potential economic impact on Auckland of each scheme. The impact on businesses has been estimated based on the changes each scheme is expected to create in terms of altered travel patterns and journey times and the impact of the congestion charge itself. Table 10 provides a summary of the results of this analysis.

107. The analysis presented here represents average outcomes: clearly some businesses will perceive a much greater value from the ability to travel in less congested conditions than others. The analysis below examines the impact on commercial vehicle (CV) and non-home-based (NHB) trips in RART as a reasonable proxy for a comprehensive coverage of business trips. The analysis therefore excludes Home-Based trips as these are primarily considered to be home to work and leisure related.

Benefit-Cost Analysis

108. A simple benefit-cost ratio (BCR) evaluation has been undertaken for each scheme. The benefit estimates are based on RART[11] outputs while the costs and revenues estimates are extracted from the financial analysis that includes capital and operating components of both the scheme costs and the mitigation costs.

109. The schemes being considered charge road users over the four-hour AM peak charging period. Public transport (PT) services will be expanded as part of the mitigation works to provide for a greater level of public transport patronage that is expected due to mode shift changes associated with the charging schemes. Typically, these schemes:

- increase the monetary costs of car travel (through the charges);
- reduce the time costs of car travel (as traffic volumes and congestion are reduced);
- reduce the in-vehicle time costs of PT travel (as bus journey times will be reduced on less congested road networks); and
- reduce the waiting time costs of PT travel (as service frequencies are improved to cater for the increased PT patronage).

110. The following table summarises the estimated BCR of each pricing scheme, excluding the costs of the mitigation works. The BCR inclusive of mitigation works is included in Table 9.

Table 8 BCR Results Excluding Mitigation Costs

	Single Cordon	Double Cordon	Area	Strategic Network	Parking Levy
BCR	3.5 (2.4-6.5)	2.9 (2.0-5.5)	2.3 (1.6-4.3)	0.7 (0.5-1.3)	4.0 (2.7-7.4)

111. Some points worthy of note in the outcomes of the BCR analysis include:

- The Strategic Network Charging scheme BCR is very low compared with that of the other schemes. This is a due to the combination of the higher operating costs and the shift of traffic from the strategic network to the local road network.
- The Strategic Network Charging scheme is the only scheme where such a trade-off in travel time benefits on the charged network are offset by negative effects on local roads and the impact on the benefits stream is large.
- The Parking Levy scheme is comparatively cheap to implement and achieves benefits related to the mode shift to public transport, which is greater due to the higher availability of public transport services in the areas charged in this scheme.

Table 9 BCR Results Including Mitigation Costs

	Single Cordon	Double Cordon	Area	Strategic Network	Parking Levy
BCR	1.8 (1.3-3.4)	1.8 (1.3-3.5)	1.6 (1.1-3.0)	0.5 (0.3-0.9)	3.5 (2.4-6.6)

112. These BCR values compare outcomes of the analysis based on certain major assumptions. However, the schemes being compared are significantly different (in concept and application) and the results need to be considered in that perspective.

[11] The RART model is a strategic model developed for this study. It is suitable for the modelling of the road pricing schemes at the broad analytical level. However, it has not been calibrated and validated to the requirements of the Land Transport NZ Project Evaluation Manual (PEM) and is therefore not entirely accurate to the levels required by those procedures.

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113. The first table of BCR results (without mitigation) may overestimate the BCR as the benefits of mitigation are largely included, but the costs are not. The second table of BCR results is likely to underestimate the BCR, as the full costs of mitigation works include some components (such as integrated fares) that may not be necessary for the mitigation of road pricing scheme impacts, but are relatively costly. Further refinement to determine the best package of mitigation works could produce BCR results that fall somewhere in a range indicated by the two tables above.

Business Sector Impacts

114. The impacts of road pricing schemes on Auckland businesses arise from:

- effects on business trip-making behaviour, primarily through fewer trips and also through changes in trip mode and/or timing; and
- effects on business costs, both out-of-pocket dollar costs - through payment of road charges, public transport fares, parking charges and vehicle operating costs - and the value of time or convenience, arising from changes in trip-making behaviour by directly impacted businesses, and/or from changes in travel time for other businesses.

115. For the business sector, both actual out-of-pocket dollar costs and time costs incurred or savings made are reflected in business costs. For the business sector "time is money", and travel time savings generally reduce wage and salary costs, as well as lowering costs of vehicle operation. Both types of cost and benefit can be estimated in annual dollar terms, and out-of-pocket dollar costs are estimated as a share of business income to indicate the significance of road charges.

116. The less direct impacts are:

- effects on business activity, through reduction in home-work trips to more expensive destinations, reducing the availability of labour for businesses; and
- effects on business demand, through suppression of trips and/or redirection to other destinations.

117. Data derived from RART has been analysed to show a range of impacts in some detail. The most significant impact indicators are the:

- impact on trip activity arising from charges. The base case level of trip activity (numbers of trips, kilometres travelled) is assumed to reflect a satisfactory situation for existing businesses, on the grounds that they do not travel more than necessary to carry out day-to-day business activity (i.e. approximately efficient for the current cost of travel). Any change in trip numbers in response to road pricing represents some benefit or cost to business, as the level of inter-business activity (movement of goods and people) will be correspondingly increased or reduced;
- aggregate impact on business sector trip-making, which includes total trips made, total distance travelled, and total dollar and time costs of trips, including charges; and
- incidence of impacts among trips still made, in terms of the numbers incurring charges or involving a change in mode, expressed also as a % share of the base number of trips[12].

[12] Note that the model results showing the numbers of trips not made also include trips which are re-timed out of the peak period, and may be made subsequently. It is assumed that any which are re-timed are made after 10am, to avoid charges

Direct Costs to Businesses

118. There are 184,230 business trips projected for the 6-10am morning peak period for 2016. The economic impact on businesses of the road charging schemes under consideration varies considerably. The significant changes in trip activity and costs during the 6-10am peak are summarised in Table 10.

Table 10 Impacts on Business Trips (CV and NHB trips)

Indicator	Base Case	Single Cordon	Double Cordon	Area	Strategic Network	Parking Levy
Total Trip Activity						
Trips Made per day (000 incl Changed Mode)	184	185	184	173	183	185.5
CV and NHB Trips Made per day	171	171	170	158	169	172
Total Trip Cost ($000/day exc RP)	$314	$312	$304	$306	$310	$322
Total Trip Cost ($000/day incl RP)	$314	$395	$408.5	$430	$398	$322
Total Trip Time Cost ($000/day)	$973	$968	$971	$1,000	$980	$968
Total Trip Cost ($000/day excl RP)	$1,287	$1,280	$1,275	$1,307	$1,290	$1,290
Total Road Pricing Cost ($000/day)	**$0**	**$83**	**$104**	**$124**	**$88**	**$0**
Total Trip Cost ($000/day inc RP)	$1,287	$1,363	$1,379	$1,431	$1,378	$1,290
Change in Total Trips (%)	0.0%	0.3%	-0.3%	-6.0%	-0.7%	0.7%
Trips Incurring Charges (n)	0	23,832	26,017	45,746	49,315	0
Trips Incurring Charges (%)	0.0%	12.9%	14.1%	24.8%	26.8%	0.0%
Trips Changed Mode (%)	0.0%	0.1%	0.3%	1.0%	0.2%	0.1%
Total Trips Impacted (as % Base)	0.0%	13.4%	15.1%	35.0%	28.0%	0.8%
Trips Not Impacted (%)	100.0%	86.6%	84.9%	65.0%	72.0%	99.2%
Total Trip Distance (000 km)	1,805	1,794	1,746	1,761	1,781	1,853
Change in Total Trip Distance	0.0%	-0.6%	-3.3%	-2.4%	-1.3%	+2.7%
Trip Parameters						
Change in Total Trip Dollar Cost	0.0%	-0.6%	-3.1%	-2.5%	-1.3%	2.5%
Change in Trip Time Cost	0.0%	-0.5%	-0.2%	2.8%	0.7%	-0.5%
Change in Total Trip Cost (excl RP)	0.0%	-0.6%	-0.9%	1.5%	0.2%	0.2%
Change in Total Trip Cost (incl RP)	0.0%	+5.9%	+7.2%	+11.2%	+7.1%	+0.2%
Average for Trips Made						
Change in Mean Trip Cost (incl RP)	0.0%	+5.5%	+7.4%	+18.3%	+7.8%	-0.5%
Change in Mean Trip Distance	0.0%	-0.9%	-3.0%	+3.8%	-0.7%	+1.9%
Change in Mean Cost for Trips which incur scheme charge	**0.0%**	**63%**	**70%**	**62%**	**41%**	**N/A**

119. Overall, the following conclusions can be reached:

- With respect to business ***trip numbers***, the greatest reduction in business trips occurs under the Area scheme, with 6% fewer trips. This is a significant reduction, which either reflects trips not made at all – with consequent reduction in associated business activity; or trips re-timed – with consequent re-timing of associated business activity. The Strategic Network Charging and Double Cordon schemes also result in small reductions in trip activity, while the Single Cordon and Parking Levy schemes result in small increases in trip activity.
- Examining business ***trips impacted***, whether by paying a charge or taking action to avoid the charge, the Area scheme again affects a higher percentage of business trips than other

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schemes at 35.0% overall, including 24.8% incurring charges. A high proportion (28.0%) of business trips are also affected by the Strategic Network Charging scheme. A much lower proportion of trips are impacted in the Single Cordon (13.4%) and Double Cordon (15.1%) schemes, although the effect is still quite significant.

- The increase in average ***trip costs*** (including the charges) varies considerably. The Single Cordon and Double Cordon scheme increases are 5.5% and 7.4% respectively, while the Strategic Network Charging scheme increase is higher at 7.8%. However, the Area charge results in an increase of 18.3%, driven partly by the incidence of road charges, and partly by the increase in trip time.
- The additional cost is heavily weighted toward those trips incurring charges - their increase in ***average trip costs for trips incurring the charge*** varies from $2.83, or 41%, for the Strategic Network Charging scheme to $4.89, or 70%, for the Double Cordon scheme. This increase is largely driven by the relative charge levels.
- For those ***trips not incurring charges***, the average total trip cost reduces slightly in all cases (by around -35 to -4%), except the Area scheme, where overall average costs still increase by 2.6% due to trip time increases. Average trip distance of those trips still made increases by 3.8%, which may be due to a combination of a loss in very short trips (buzzing around the CBD), as well as a lengthening of some trips as vehicles seek to avoid the charging area, perhaps by using the Western Ring Route rather than SH1 for through-trips. Note that excluding charges, total business trip dollar operating costs for the Area scheme reduce by -2.5%.
- The ***Parking Levy scheme*** has very limited impacts on business trips, primarily due to the RART assumption[13] that, being primarily commercial vehicle and non home based trips, no business trips (CV/NHB) would pay the charge as they would tend to use more informal parking facilities such as loading bays/zones.

Wider Impacts on the Auckland Economy

Earlier Studies on Costs of Congestion

120. A number of studies have attempted to quantify the cost of congestion to Auckland as a whole, with estimates ranging from $730m to $900m ($2005). These estimates allocate a value of the time lost due to congestion to all trips made in Auckland (although the higher figure includes a component which attempts to address the additional costs to freight/logistics companies). Three points are worth noting:

- These figures estimate the total value of time lost to congestion through the entire year (24/7 and 365 days). One study calculated that the value of time lost due to congestion during peak travel periods alone was less than 50% of the total estimated cost of congestion.
- Business trips made during the 6-10am period in Auckland (184,000 trips per day) represent less than 15% of all trips made across the Auckland network during that period (across all modes) and less than 25% of all vehicle trips. Although delays in commuter trips would have some impact on businesses, these impacts would tend to be less direct.

[13] Note that this was a modelling assumption only. It is not proposed that commercial vehicles should be exempt from parking levies.

Therefore, a very large proportion of the value of time lost due to congestion accrues to private individuals and affects leisure time rather than working hours and hence has less impact on the wider economy in terms of GDP.

- The modelling carried for this study suggests that the schemes have the potential to reduce the percentage of kilometres travelled in congested conditions during the morning peak period from around 20% to around 12%. Setting aside consideration of "optimal" levels of congestion, while some congestion remains so will a proportion of the "costs" as calculated by these studies.

Economic Impact Conclusions from this Study

121. Businesses in Auckland view traffic congestion as a problem. Long trip times during peaks and uncertainty about trip times inevitably result in economic inefficiencies and higher costs to do business in Auckland. Such costs may manifest themselves either in lower rates of productivity, or higher labour or other variable costs in order to boost capacity to make deliveries to meet demand (e.g. for freight or logistics companies).

122. The economic impact analysis concludes that the schemes' impact may be neutral or even slightly negative, depending on how the revenues raised are put back into the economy. If it is assumed that no revenues are re-injected back into the economy there is likely to be a relatively small negative impact on the Auckland economy from the imposition of road user charges.

123. How funds are used will determine the distribution and size of any offsetting benefit. The study has assumed that much of the revenues raised would be used to improve public transport in the Auckland region. This should benefit the Auckland economy.

124. This analysis ignores issues of distribution equity across business sectors, although impacts are quite widely spread across different activities. This reflects both the relative use of the road network, and the relative concentration of activities in and around the central isthmus, where most of the impacts occur. On the other hand, it also largely ignores the wider societal benefits from reduced congestion, including the value of time savings to households.

125. The detailed analysis of results on Auckland businesses appears to show that implementing any of charging schemes assessed in this report (ignoring for a moment, how the revenues raised are used) would result in a small negative effect on the business sector. The vehicle cost and time benefits from road pricing equate to only 5-20% of the costs incurred in road pricing, so when the charges are included, the business sector costs would increase in net terms under all schemes. However, the increase in business sector costs is small – the net increase is equivalent to less than 0.01% of total business costs.

126. While lower congestion costs must result from an effective road pricing scheme, this cost reduction translates into a relatively modest real financial impact on businesses that flows through to the economy as a whole. Positive and negative effects of the scheme largely seem to offset each other. One reason for this may be that the marginal costs of road pricing to businesses is generally small as transportation costs generally are not a hugely significant cost to businesses. Equally, the direct and tangible benefits to be gained by businesses from reductions to congestion do not seem large.

127. Across the wider economy, there would be a small net negative effect on consumer expenditure, as there is a net cost to households of $25m-$89m (out-of-pocket costs) annually to pay for road charges which is not offset by time savings, as these are less tangible to the household sector. The effect on the economy as a whole would be about one-third to half the effect on household consumption, in the range of 0.05% to 0.24%.

128. The potential offset is in the increased efficiency in the economy, arising from both dollar and time savings. In each scheme the value of time savings is less than the cost of the scheme, indicating that the increase in efficiency is not sufficient to offset the additional costs. However, if there were no net leakage of earnings from the schemes, and the travel time savings were realised, then the economy as a whole would be no smaller, and slightly more efficient.

Social Impact Assessment

129. Charging for road use to reduce the number of motor vehicle trips by its nature places additional out-of-pocket costs on people who still have to travel and cannot move to cheaper alternatives. The direct financial social impact is therefore negative. However, non-quantifiable impacts such as reduced travel times (with potential impacts on leisure time and time with families, etc) would also accrue. In considering the social impacts outlined below we have examined the extent to which:

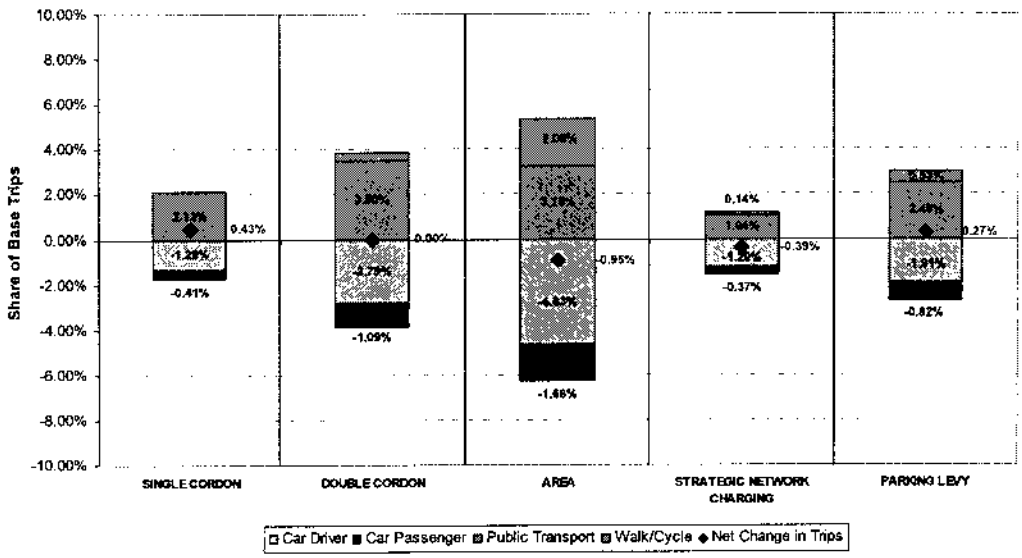
    a. existing congestion already imposes a non-financial social cost; and

    b. adverse social effects driven by the scheme charges can be mitigated for those most materially affected.

130. The social impact analysis was designed to consider the impact of each scheme on Auckland households. The analysis shows the effect of pricing schemes on households in general, and on directly affected households, throughout Auckland. This is primarily a statistical assessment, to identify the numbers of households affected, the nature and scale of impacts (out-of-pocket dollar costs and benefits, and access and mobility impacts including time/convenience costs and benefits), the significance of such impacts, and the distribution of impacts geographically and within the household sector.

131. The base case shows 1,116,900 trips by households in the 6am-10am period on a weekday on the 2016 unpriced network, an average of 2.1 trips per household. Figure 5 shows the net impact of each scheme on the total number of household trips undertaken (by mode) throughout Auckland. Blocks below the line represent the share of base trips (by mode) no longer undertaken as a result of each scheme, while the blocks above the line represent additional trips undertaken (by mode) expressed as a share of base trips. The net result of these increases and decreases in trips by mode are represented by the black diamonds.

Figure 5 Change in Total Trips by Mode



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132. The Single Cordon and Parking Levy schemes both slightly increase total trips, as the overall cost of trip-making is reduced. The Area scheme results in the greatest net decrease in trip numbers (-0.95%), while the Strategic Network Charging scheme results in a smaller net decrease (-0.39%). The Double Cordon scheme has no net impact on the total number of trips made.

Impacts on Household Behaviour in the 6-10am period[14]

Table 11 Impacts on Household Behaviour

		SINGLE CORDON 6-10am		DOUBLE CORDON 6-10am		AREA 6-10am		STRATEGIC NETWORK CHARGING 6-10am		PARKING LEVY 6-10am	
		n	%	n	%	n	%	n	%	n	%
IMPACTS ON TRIPS											
Base Trips (2016)		1,116,900	100%	1,116,900	100%	1,116,900	100%	1,116,900	100%	1,116,900	100%
Trips Impacted											
Charge Avoidance		38,500	3%	42,400	4%	70,100	6%	17,600	2%	36,600	3%
Change Trip Mode (Increase PT & WC)		*23,700*	*2%*	*42,200*	*4%*	*59,500*	*5%*	*13,200*	*1%*	*33,600*	*3%*
Change Number of Trips - Net (incl Reb		*4,800*	*0%*	*200*	*0%*	*-10,600*	*-1%*	*-4,400*	*0%*	*3,000*	*0%*
Increase		8,900	1%	8,500	1%	6,300	1%	1,700	0%	6,500	1%
Decrease		-4,100	0%	-8,700	-1%	-16,900	-2%	-6,100	-1%	-3,500	0%
Trips Charged		74,200	7%	89,600	8%	81,200	7%	88,600	8%	25,400	2%
Total Trips Impacted		**102,700**	**9%**	**132,000**	**12%**	**151,300**	**14%**	**106,200**	**10%**	**62,000**	**6%**
Total Trips Not Impacted		1,014,200	91%	984,900	88%	965,600	86%	1,010,700	90%	1,054,900	94%
HOUSEHOLDS IMPACTED											
Base Households (2016)		**519,100**	**100%**	**519,100**	**100%**	**519,100**	**100%**	**519,100**	**100%**	**519,100**	**100%**
Households Impacted											
Charge Avoidance	Min	20,900	4%	33,600	6%	48,100	9%	11,800	2%	26,300	5%
	Max	36,700	7%	59,400	11%	82,700	16%	21,000	4%	43,600	8%
Trips Change Mode (Increase P)	*Min*	*14,600*	*3%*	*25,300*	*5%*	*36,900*	*7%*	*8,000*	*2%*	*21,400*	*4%*
	Max	*23,700*	*5%*	*42,200*	*8%*	*59,500*	*11%*	*13,200*	*3%*	*33,600*	*6%*
Change Number of Trips - Net (-Min		*6,300*	*1%*	*8,300*	*2%*	*11,200*	*2%*	*3,800*	*1%*	*4,900*	*1%*
	Max	*13,000*	*3%*	*17,200*	*3%*	*23,200*	*4%*	*7,800*	*2%*	*10,000*	*2%*
Trips Charged	Min	45,700	9%	53,800	10%	50,600	10%	55,600	11%	15,700	3%
	Max	74,200	14%	89,600	17%	81,200	16%	88,600	17%	25,400	5%
Total Households Impacted	Min	**66,600**	**13%**	**87,400**	**17%**	**98,700**	**19%**	**67,400**	**13%**	**42,000**	**8%**
	Max	**110,900**	**21%**	**149,000**	**29%**	**163,900**	**32%**	**109,600**	**21%**	**69,000**	**13%**
Total Households Not Impacted	Min	452,500	87%	431,700	83%	420,400	81%	451,700	87%	477,100	92%
	Max	408,200	79%	370,100	71%	355,200	68%	409,500	79%	450,100	87%

133. Table 11 summarises the impacts on trips and households of the schemes. Notable points are:

- The **Single Cordon** scheme impacts 9% of all trips undertaken in the 6-10am period. Most of these trips are affected by the charge to cross the cordon. The remainder are impacted by actions to avoid the charge, predominantly through switching mode to public transport or walk/cycle. 13-21% of households are affected.
- A higher proportion of trips (12%) are impacted by the **Double Cordon scheme**. Two thirds of these trips incur a charge. The remaining third of impacted trips avoid the charge, again predominantly through switching modes. 17-29% of households are affected.
- The highest proportion of trips are impacted by the **Area** scheme (14%). Half of these impacted trips are charged. The Area scheme also has the highest proportion of trips which switch modes and in turn the highest proportion of households (19-32%) are affected.
- Under the **Strategic Network Charging** scheme, 10% of trips are impacted. The majority of these trips are impacted through incurring the charge and only a small number switch mode or cease to travel. 13-21% of households are impacted by this scheme.
- The **Parking Levy** scheme impacts the fewest trips (6%). This is because the Parking Levy scheme mainly affects commuters ending in Takapuna, the CBD, Newmarket, Henderson or Manukau. Only a third of these trips are affected through paying the charge. 8-13% of households are affected by this scheme – the lowest share of all schemes.

[14] The maximum number of households impacted assumes that each impacted trip is undertaken by a separate household. The minimum number of households impacted assumes that any impacted household undertakes an average of 1.7 trips. In reality, the most likely number of impacted households is likely to be closer to the maximum than the minimum, with best estimates in the region of 60-70% of the maximum numbers identified.

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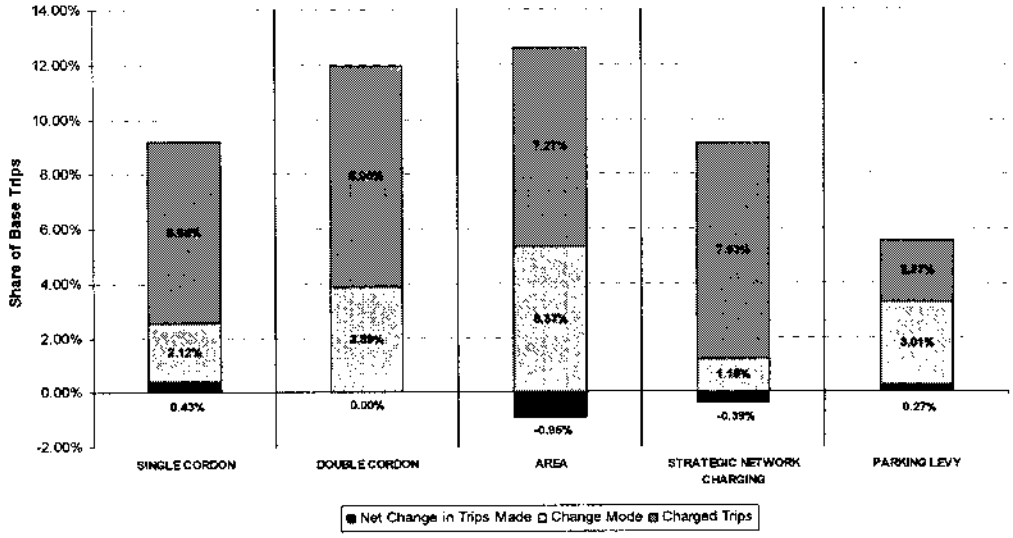
134. The figure below summarises how trips are impacted by each scheme.

Figure 6 Summary of Trip Impacts



135. Impacts are relatively even across all household types, with the exception of 65+ years single person households, which have lower shares reflecting their lower propensity to travel by car.

Out-of-pocket Costs

136. Out-of-pocket costs represent tangible costs that have a visible impact on household expenditure. Out-of-pocket costs are a significant share of total net costs (including time costs). Table 12 shows total out-of-pocket costs for each scheme by household type.

Table 12 Annual Average Out-of-Pocket Costs for Impacted Households by Type (Maximums)[15]

	OUT OF POCKET COSTS 6-10am				
	SINGLE CORDON	DOUBLE CORDON	AREA	STRATEGIC NETWORK CHARGING	PARKING LEVY
AVERAGE ANNUAL OUT OF POCKET COST PER IMPACTED HOUSEHOLD					
Total	**$ 957**	**$ 1,015**	**$ 905**	**$ 376**	**$ 1,490**
Single Person 15-29 Yrs Q1-Q5	$ 717	$ 780	$ 712	$ 228	$ 1,287
Single Person 30-64 Yrs Q1-Q2	$ 652	$ 692	$ 645	$ 201	$ 1,203
Single Person 30-64 Yrs Q3-Q5	$ 607	$ 640	$ 572	$ 234	$ 843
Single Person 65+ Yrs Q1-Q5	$ 619	$ 611	$ 513	$ 228	$ 1,105
Couple 15-64 Yrs Q1-Q3	$ 991	$ 1,092	$ 969	$ 334	$ 1,729
Couple 15-64 Yrs Q4	$ 808	$ 873	$ 802	$ 344	$ 1,137
Couple 15-64 Yrs Q5	$ 720	$ 763	$ 726	$ 364	$ 933
Couple 65+ Yrs Q1-Q5	$ 635	$ 642	$ 563	$ 250	$ 1,055
2 Parent Family 15-29 Yrs Q1-Q3	$ 1,328	$ 1,432	$ 1,358	$ 476	$ 2,724
2 Parent Family 15-29 Yrs Q4-Q5	$ 1,083	$ 1,163	$ 1,103	$ 507	$ 1,591
2 Parent Family 30+ Yrs Q1-Q3	$ 1,422	$ 1,546	$ 1,423	$ 489	$ 2,759
2 Parent Family 30+ Yrs Q4	$ 1,217	$ 1,280	$ 1,178	$ 541	$ 1,815
2 Parent Family 30+ Yrs Q5	$ 1,014	$ 1,076	$ 1,027	$ 511	$ 1,423
1 Parent Family 15-29 Yrs Q1-Q5	$ 961	$ 1,052	$ 927	$ 323	$ 1,853
1 Parent Family 30-49 Yrs Q1-Q2	$ 946	$ 1,028	$ 910	$ 323	$ 1,905
1 Parent Family 30-49 Yrs Q3-Q5	$ 926	$ 1,008	$ 899	$ 373	$ 1,448
1 Parent Family 50+ Yrs Q1-Q5	$ 975	$ 1,067	$ 958	$ 335	$ 1,734
Multi-Family All Ages Q1-Q4	$ 1,568	$ 1,738	$ 1,630	$ 580	$ 2,920
Multi-Family All Ages Q5	$ 1,535	$ 1,635	$ 1,507	$ 738	$ 2,213
Non Family Household Q1-Q3	$ 1,037	$ 1,139	$ 1,023	$ 343	$ 1,940
Non Family Household Q4-Q5	$ 920	$ 985	$ 906	$ 423	$ 1,244

Figures in blue denote less than 50% of total annual average per household
Figures in red denote more than 150% of total annual average per household

[15] In this table, "Q" refers to the relevant income group for the household type. These have been divided into 5 "quintiles" for this study, grouped on the advice of the Ministry of Social Development. Multi-family households have >1 parent and non-family households are boarding/flatting arrangements.

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137. When out-of-pocket costs are considered as a share of net household income, patterns change noticeably (see Table 13). While the average out-of-pocket costs range between 0.8% for Strategic Network Charging and 3.1% for the Parking Levy scheme, shares are significantly higher for some household types. Households with the lowest household incomes are hit hardest by all schemes, in particular lower-income one and two parent families, as well as younger one parent families.

Table 13 Annual Average Out-of-pocket Costs as a Share of Net Average Household Income for Impacted Households by Household Type (Maximum Shares)

	OUT OF POCKET COSTS 6-10am				
	SINGLE CORDON	DOUBLE CORDON	AREA	STRATEGIC NETWORK CHARGING	PARKING LEVY
AV. ANN. OUT OF POCKET COST AS SHARE OF AVERAGE HOUSEHOLD INCOME					
Total	**2.0%**	**2.1%**	**1.9%**	**0.8%**	**3.1%**
Single Person 15-29 Yrs Q1-Q5	2.7%	3.0%	2.7%	0.9%	4.9%
Single Person 30-64 Yrs Q1-Q2	3.9%	4.1%	3.8%	1.2%	7.1%
Single Person 30-64 Yrs Q3-Q5	1.3%	1.3%	1.2%	0.5%	1.7%
Single Person 65+ Yrs Q1-Q5	3.5%	3.4%	2.9%	1.3%	6.2%
Couple 15-64 Yrs Q1-Q3	3.2%	3.6%	3.2%	1.1%	5.6%
Couple 15-64 Yrs Q4	1.4%	1.6%	1.4%	0.6%	2.0%
Couple 15-64 Yrs Q5	0.9%	1.0%	0.9%	0.5%	1.2%
Couple 65+ Yrs Q1-Q5	1.9%	1.9%	1.7%	0.7%	3.1%
2 Parent Family 15-29 Yrs Q1-Q3	4.2%	4.6%	4.2%	1.5%	8.7%
2 Parent Family 15-29 Yrs Q4-Q5	1.7%	1.8%	1.7%	0.8%	2.5%
2 Parent Family 30+ Yrs Q1-Q3	4.4%	4.8%	4.4%	1.5%	8.6%
2 Parent Family 30+ Yrs Q4	2.0%	2.1%	1.9%	0.9%	3.0%
2 Parent Family 30+ Yrs Q5	1.3%	1.4%	1.3%	0.6%	1.8%
1 Parent Family 15-29 Yrs Q1-Q5	3.9%	4.2%	3.7%	1.3%	7.5%
1 Parent Family 30-49 Yrs Q1-Q2	5.3%	5.8%	5.1%	1.8%	10.8%
1 Parent Family 30-49 Yrs Q3-Q5	1.9%	2.0%	1.8%	0.8%	2.9%
1 Parent Family 50+ Yrs Q1-Q5	2.5%	2.7%	2.4%	0.9%	4.4%
Multi-Family All Ages Q1-Q4	3.6%	3.9%	3.7%	1.3%	6.8%
Multi-Family All Ages Q5	1.9%	2.1%	1.9%	0.9%	2.8%
Non Family Household Q1-Q3	3.7%	4.1%	3.7%	1.2%	6.9%
Non Family Household Q4-Q5	1.4%	1.5%	1.3%	0.6%	1.8%

Percentages in blue denote less than 50% of total share of household income
Figures in red denote more than 150% of total share of household income

138. Although the Parking Levy scheme affects relatively few households, it imposes a relatively high financial burden on those affected.

Environmental Impact Assessment

139. In general, reduced vehicle use improves environmental performance, for example through reduced emission levels. However, it is important to examine the local impacts as well as the overall picture to understand the benefits and whether traffic diversion creates problems in other places.

140. The figures presented relate to the AM peak period in 2016. All figures are expressed as percentage change over the base scenario. A positive percentage represents an improvement over the base situation, while a negative percentage represents deterioration in conditions.

Table 14 Summary of Environmental Impact Indicators[16]

Indicator	Single Cordon	Double Cordon	Area	Strategic Network	Parking Levy
VKT reductions - sensitive catchments	7.0%	10.9%	9.3%	5.3%	2.9%
Particulate discharge reductions - PM10	12.2%	17.8%	13.9%	12.5%	4.6%
Amenity (traffic volume reductions on arterials)	5.1%	4.5%	4.5%	5.8%	3.1%

[16] Red and green highlighting has been used to highlight particular effects. Red cells (with white text) indicate conditions that are worse than the base situation, while green cells highlight improvements in conditions, in broad terms where a 10% or greater improvement is expected.

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141. Table 14 provides a high level summary of the results of the environmental impact analysis for each scheme. Notable points are:

- Environmental improvements are strongly related to the level of the scheme charge and the number of affected trips. The higher the charge, the bigger the benefit. The only exception is the Strategic Network Charging scheme, where there is likely to be a significant impact on conditions on arterial and local roads from traffic that formerly used the now charged network; this impact grows as the charge increases and has an impact on amenity values in particular.
- In terms of road-based contamination of waterways and the marine environment, the Double Cordon scheme generates the largest reduction in the amount of VKT in stormwater catchments that may be particularly sensitive to additional contaminant loads. The Parking Levy scheme has the least effect on VKT. However, both the Double Cordon and Area schemes, while seeing in the largest falls in VKT across all of the identified catchments, *increase* VKT in catchments that drain to the high-value Upper Harbour area. The effects of this increased VKT could be mitigated through additional stormwater treatment. The Single Cordon scheme sees a more modest reduction in VKT across all catchments, and no single catchment sees increased contaminant loads over the base case.
- For air quality, the Double Cordon scheme would most reduce emissions into the regional air shed. The Area and Strategic Network schemes, while producing an overall reduction across the region, would result in some local increases in air discharges. The Area scheme leads to increased emissions in the western urban sector, while the Strategic Network Charging scheme increases emission levels along arterial roads and local roads. The increase in air emissions along arterial and local roads is likely to pose particular issues for activities (for example walking and cycling) where exposure levels may be high and would be difficult to mitigate. The Cordon-based schemes may therefore provide the best outcome.
- Traffic levels on selected roads show the effect of the road pricing schemes on amenity conditions at a community level. The Single Cordon and Area schemes reduce traffic on those roads. The Area scheme sees most of the reduction within the geographic area covered by the scheme, while the Cordon schemes produce a more even reduction across the urban area. The Strategic Network Charging scheme increases traffic on local roads, especially in the isthmus area.

New Zealand Transport Strategy Assessment

142. Table 15 summarises the findings from the perspective of the NZTS. The assessment shows that:

- the Double Cordon and Area schemes demonstrate clear contributions to a number of the main NZTS objectives but
- the Single Cordon, Strategic Network Charging and Parking Levy schemes show only modest or no contribution to most of the main objectives.

Table 15 Summary Performance Against NZTS Objectives

NZTS Objective	Single Cordon	Double Cordon	Area	Strategic Network	Parking Levy
Assisting Economic Development	*Reduction of vehicle trips* *Small reduction in average trip length* *Large incr in avg trip speed* *Large decrease in average vehicle travel time* *Reduction in % travel in congested/LOS E/F conditions* *Estimated ratio of benefits to costs including mitigation 1.8* *13.4% of business trips impacted. 13% incur charges* *22% reduction in home-work travel times to key economic centres*	*Reduction of vehicle trips* *Small reduction in average trip length* *Large incr in avg trip speed* *Large decrease in average vehicle travel time* *Largest reduction in % of travel in congested conditions* *Estimated ratio of benefits to costs including mitigation 1.8* *15% of business trips impacted. 14% incur charges* *21% reduction in home-work travel times to key economic centres*	*Biggest reduction of veh trips* *No discernable change in average trip length* *Modest incr in avg trip speed* *Modest decrease in average vehicle travel time* *Reduction in % of travel in congested conditions* *Estimated ratio of benefits to costs including mitigation 1.6* *35% of business trips impacted. 25% incur charges* *11% reduction in home-work travel times to key economic centres*	*Reduction of vehicle trips* *Small reduction in average trip length* *Marginal incr avg trip speed* *Marginal decrease in average vehicle travel time* *Reduction in % of travel in congested conditions* *Estimated ratio of benefits to costs including mitigation 0.5* *28% of business trips impacted. 27% incur charges* *7% reduction in home-work travel times to key economic centres*	*Reduction of vehicle trips* *No discernable change in average trip length* *Marginal incr avg trip speed* *Marginal decrease in average vehicle travel time* *Marginal reduction in % of travel in congested conditions* *Estimated ratio of benefits to costs including mitigation 3.5* <*1% of business trips impacted* *10% reduction in home-work travel times to key economic centres*
Assisting Safety	*Total expected reduction in injury crashes of 7%*	*Total expected reduction in injury crashes of 9%*	*Total expected reduction in injury crashes of 8%*	*Total expected reduction in injury crashes of 1%*	*Total expected reduction in injury crashes of 3%*
Improving Access and Mobility	*Reasonable trip reliability results (5% increase in speed/free-flow speed, 30% reduction in travel on a congested network)* *17% increase in passenger transport trips* *40% increase in home-work (commuting) passenger transport trips* *31% increase in passenger transport kilometres travelled* *General reductions in sector-sector commuting times* *Marginal increases in number of short trips by "active modes" (walking and cycling)*	*Best trip reliability results (7% increase in speed/free flow speed, 40% reduction in travel on a congested network)* *29% increase in passenger transport trips* *66% increase in home-work (commuting) passenger transport trips* *46% increase in passenger transport kilometres travelled* *General reductions in sector-sector commuting times* *Marginal increases in number of short trips by "active modes"*	*Reasonable trip reliability results (5% increase in speed/free flow speed, 27% reduction in travel on a congested network)* *29% increase in passenger transport trips* *63% increase in home-work (commuting) passenger transport trips* *36% increase in passenger transport kilometres travelled* *General reductions in sector-sector commuting times* *Reasonable increases in number of short trips by "active modes".*	*Reasonable trip reliability results (2% increase in speed/free flow speed, 26% reduction in travel on a congested network)* *9% increase in passenger transport trips* *19% increase in home-work (commuting) passenger transport trips* *16% increase in passenger transport kilometres travelled* *Some increased in sector-sector commuting times* *Marginal increases in number of short trips "active modes".*	*Marginal trip reliability results (2% increase in speed/free flow speed, 10% reduction in travel on a congested network)* *21% increase in passenger transport trips* *51% increase in home-work (commuting) passenger transport trips* *28% increase in passenger transport kilometres travelled* *General reductions in sector-sector commuting times* *Marginal increases in number of short trips by "active modes".*

NZTS Objective	Single Cordon	Double Cordon	Area	Strategic Network	Parking Levy
Protecting and Promoting Public Health	*1% decrease in walking and cycling person-kilometres travelled* *12.2% reduction in air discharges (PM10)*	*2% increase in walking and cycling person-kms travelled* *17.8% reduction in air discharges (PM10)*	*9% increase in walking and cycling person-kms travelled* *13.9% reduction in air discharges (PM10)*	*No change in walking and cycling person-kms travelled* *12.5% reduction in air discharges (PM10)*	*3% increase in walking and cycling person-kms travelled* *4.6% reduction in air discharges (PM10)*
Ensuring Environ-mental Sustain-ability	*7.0% reduction in VKT travelled in stormwater catchments sensitive to additional contaminant loads* *5.1% reduction in traffic levels on arterial roads in communities* *11.9% incr vehicle speed to key employment areas* *4.7% increase in non-vehicle trips to sub-regional centres*	*10.9% reduction in VKT travelled in stormwater catchments sensitive to additional contaminant loads* *4.5% reduction in traffic levels on arterial roads in communities* *14.5% incr vehicle speed to key employment areas* *10.2% increase in non-vehicle trips to sub-regional centres*	*9.3% reduction in VKT travelled in stormwater catchments sensitive to additional contaminant loads* *4.5% reduction in traffic levels on arterial roads in communities* *12.6% incr vehicle speed to key employment areas* *17.8% increase in non-vehicle trips to sub-regional centres*	*5.3% reduction in VKT travelled in stormwater catchments sensitive to additional contaminant loads* *5.8% increase in traffic levels on arterial roads in communities* *0.7% decr vehicle speed to key employment areas* *4.5% increase in non-vehicle trips to sub-regional centres*	*2.9% reduction in VKT travelled in stormwater catchments sensitive to additional contaminant loads* *3.1% reduction in traffic levels on arterial roads in communities* *5.8% incr vehicle speed to key employment areas* *36.0% increase in non-vehicle trips to sub-regional centres*
Energy Efficiency	*Reduction of vehicle trips* *Largest reduction in % of travel in congested conditions (LOS E/F)* *9% reduction in fuel use*	*Reduction of vehicle trips* *Reduction in % of travel in congested conditions (LOS E/F)* *13% reduction in fuel use*	*Biggest reduction of vehicle trips* *Reduction in % of travel in congested conditions (LOS E/F)* *11% reduction in fuel use*	*Reduction of vehicle trips* *Reduction in % of travel in congested conditions (LOS E/F)* *6% reduction in fuel use*	*Reduction of vehicle trips* *Marginal reduction in % of travel in congested conditions (LOS E/F)* *4% reduction in fuel use*
Affordability and Cost-effectiveness	*Overall NPV Result of -$92.1m*	*Overall NPV Result of $149.6m*	*Overall NPV Result of $349.9m*	*Overall NPV Result of -$256.7m*	*Overall NPV Result of $460.8m*

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Land Use

143. The land-use analysis has considered whether the road pricing schemes assist with the achievement of the spatial objectives of the Auckland Regional Growth Strategy (RGS). The analysis is based on land use assumptions consistent with the general direction of the RGS.

144. RART does not take into account the dynamic effect of changed transport costs on land-use decisions. Consequently judgements have been made as to whether changes in transport-related costs are likely to be large enough to alter household and business location decision-making.

145. The following table sets out indicators related to integration with RGS outcomes. The figures are the percentage change over the base situation.

Table 18 RGS Outcome Summary Indicators

Indicators	Single Cordon	Double Cordon	Area	Strategic Network	Parking Levy
Costs of vehicle access to RGS nodes, relative to non-RGS areas (excluding charges)	-6.9%	-12.5%	-14.1%	-1.4%	-12.5%
Increased speed of vehicle travel to main employment areas	11.9%	14.5%	12.6%	-0.7%	5.8%
Increase in non-vehicle trips to sub-regional centres	4.7%	10.2%	17.8%	4.5%	36.0%

146. The extent of support for RGS objectives relates to the geographic extent of the road pricing schemes:

- The Area scheme would support intensification in the central urban area, possibly to a greater extent than that anticipated by the RGS, while supporting current development plans in suburban areas outside the Area boundary. The Area scheme is likely to have the best match with regional strategy goals.
- The Cordon schemes support further development of skill-based jobs within the isthmus area, consistent with Growth and Economic Development Strategies. However they may contribute to the expansion of the peripheral urban areas as some labour intensive businesses relocate out of the cordon area to avoid the charges. Such urban expansion pressures may reduce the environmental gains associated with this scheme. A longer-term issue is the adverse effects of growth in "unpriced" vehicle travel within the Single Cordon area generated by development that would be attracted to the isthmus area by the early congestion improvements of the scheme.
- The regional land-use effects of the Strategic Network scheme are likely to be mixed, with some intensification of central areas due to improved accessibility to these areas. At the same time there is likely to be pressure for urban expansion along motorway corridors to the north and south of the isthmus area. For employment and activity centres off the motorway corridor, conditions will deteriorate as local roads become more congested.
- The land-use benefits of the Parking Levy scheme will depend on having the correct planning policies to ensure that the targeted activities (for example, retail) remain in the centre. While positive for the centres affected by the scheme, the scheme does little to assist with improved access to other areas.

Public Acceptability

147. Six hundred Auckland residents and a sample of businesses were surveyed in the course of the study. Quotas were set by broad industry type and size group (measured by employee numbers).

148. The survey showed that over half the general public in Auckland use their car every day during the morning weekday peak times and about another quarter use it at least once or twice a week. Half of the respondents rated the morning peak public transport in their area as poor or very poor.

149. While congestion is an important issue for Aucklanders, they are divided on whether road pricing is beneficial. Roughly equal numbers said that a $2.50 road charge would be a good or a bad thing for Auckland. The rating of a road charge being a good thing for Auckland drops off quickly with an increase in the charge. People's concerns about road charging are that they pay enough already (38%), it would cost too much (33%) and it's just another tax (26%).

150. If road pricing were introduced, the public would like the money spent on public transport improvements (more routes and frequency) and additional roads. Businesses are more likely to want additional roads, but still rate more public transport and integrated tickets as highly important areas for investment.

151. When asked if all the money raised was spent where they wanted it to be spent, more respondents rated road charges as a good thing. For the general public and businesses, favourability increased under all charge levels surveyed ($2.50 and $5.00), indicating that spending the money in certain areas (more frequent PT, integrated ticketing and additional roads) would have a positive effect on acceptability of road pricing.

152. The types of road charging most popular (four were tested) were parking levies and strategic network charges. This was the same for both business and the general public (although the percentages and order varied). Reasons for choosing the one they did included the fact that they thought it would be effective and that they perceived it as fairer.

153. However, the least preferred schemes were also strategic network charging and increased parking charges. Reasons people gave for why they least preferred a certain scheme included that it would cost them more and that it would be unfair.

154. These levels of support[17] are broadly comparable with London, where results remained relatively stable until road charging was introduced – and then they went up significantly:

Table 19 Public Support in Auckland and London

	Auckland	London Congestion Charging			
	2005	2002	2003 pre-pricing	2003 post-pricing	2004
Support %	38	40	39	57	54
Neither %	11	19	18	16	18
Oppose %	48	40	41	27	27

[17] Comparable support levels in Auckland were at the $2.50 charge level tested in the survey. Support levels decreased at $5, which is more broadly comparable with the actual charge levels modelled for most of the schemes.

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Part D: Conclusions

155. The table below summarises results across the five schemes. Red cells (with white text) indicate conditions that are worse than the base situation, while green cells highlight improvements in conditions, generally where a 10% or greater improvement is expected.

Scheme	Technical Feasibility	Congestion Reduction and PT Mode Share	Financial Viability	Social Impacts (Post Mitigation)	NZTS Assessment and Business Impacts	Overall Feasibility and Desirability
Base Case		20% congested VKT Avg network speed 39.5km/h 11% PT mode share				
Single Cordon Scheme	Relatively straightforward to implement toll points around cordon boundary using proven technology. Total scheme capex $78m NPV.	Reasonably effective at reducing congestion on local roads inside the cordon boundary, and on motorways. 14% congested VKT, average network speed 44km/hr. PT mode share 13% 31% increase in passenger transport kms.	Strong positive cash flows more than cover scheme operating and capital costs & yield good surpluses. However these do not cover capital and operating costs for mitigation measures. NPV (20 years) $539m net scheme revenues. NPV -$92m total revenues and costs post mitigation.	$956 annual average out-of-pocket costs to impacted households (2% average household income). For income quintile 1-3 households, ranges from 3.2% average income (couple 15-64 yrs) to 5.3% (1 parent family 30-49 yrs). Impacts challenging to mitigate.	13.4% business trips are impacted (13% pay the charge). Average trip costs (including all vehicle operating costs) for those incurring the charge increases 63% to $11.40. Overall mildly positive assessment against other NZTS objectives including Economic Development, Access & Mobility, Safety, Environmental Sustainability, Public Health and Energy Efficiency.	Relatively straightforward to implement using proven technology. Effective at reducing congestion, and moderate increase in PT mode share. Good scheme cash flows but insufficient to cover capital and operating mitigation costs. Some challenges to overcome in mitigating social impacts. Positive NZTS assessment. Weak alignment with Auckland Regional Growth Strategy.
Double Cordon Scheme	Double cordon requires more toll points than Single Cordon. Total scheme capex $89m NPV	Reasonably effective at reducing congestion on motorways and local roads inside both cordons, but with some diversion effects around both perimeters. 12% congested VKT, average network speed 44km/hr. PT mode share 14%, 46% increase in PT kms.	Very strong positive cash flows more than cover scheme operating and capital costs & yield significant surpluses which more than cover mitigation operating and capital costs. NPV (20 years) $755m net scheme revenues. NPV $150m total revenues and costs post mitigation.	$1,014 annual average out-of-pocket costs to impacted households (2% average impacted household income). For lower income quintile (Q1-3) households, ranges from 3.6% average income (couple 15-64 yrs) to 5.8% (1 parent family 30-49 yrs). Impacts challenging to mitigate.	15% business trips are impacted (14% pay the charge). Average trip costs for those incurring the charge increases 70% to $11.90. Overall strong positive assessment against NZTS Access & Mobility, Public Health, and Environmental Sustainability objectives. Overall mildly positive assessment against other NZTS objectives including Economic Development, Safety and Energy Efficiency.	Relatively straightforward to implement using proven technology. Very effective at reducing congestion, and good increases in PT mode share. Very strong financial viability, more than covers mitigation costs. Some challenges to overcome in mitigating social impacts. Strong positive NZTS assessment. Reasonable alignment with RGS.

Scheme	Technical Feasibility	Congestion Reduction and PT Mode Share	Financial Viability	Social Impacts (Post Mitigation)	NZTS Assessment and Business Impacts	Overall Feasibility and Desirability
Area Scheme	Slightly more complex than Cordon Schemes as requires toll points plus mobile enforcement units covering whole Area not just at boundary. Total scheme capex $92m NPV.	Reasonably effective at reducing congestion on local roads inside boundary and on motorways; but with diversion impacts at perimeter. 14% congested VKT, average network speed 43km/hr. PT mode share 14%, 36% increase in PT kms.	Very strong positive cash flows more than cover both scheme and mitigation operating and capital costs. NPV $805m net scheme revenues. NPV $350m total revenues and costs post mitigation.	$905 annual average out-of-pocket costs to impacted households (2% avg impacted household income). For lower income quintile (Q1-3) households, ranges from 3.2% avg income (couple 15-64 yrs) to 5.1% (1 parent family 30-49 yrs). Impacts possible to mitigate.	35% business trips are impacted (25% pay the charge). Average trip costs for those incurring the charge increases 62% to $11.20. No clear advantage against Economic Development objectives Overall strong positive assessment against NZTS Access & Mobility, Public Health and Environmental Sustainability objectives. Overall mildly positive assessment against NZTS Safety and Energy Efficiency objectives.	Moderately complex to implement. Moderately effective at reducing congestion: reductions on motorways and many local roads *inside* area boundary; however increases congestion on perimeter routes. Very strong financial viability, more than covers mitigation costs. Appears broadly possible to effectively mitigate social impacts. Strong positive NZTS assessment. Good alignment with RGS.
Strategic Network Charging Scheme	Relatively straightforward, some issues around placement of toll points. Total scheme capex $82m NPV.	Relieves congestion on motorways but increases congestion on the local road network. 15% congested VKT, average network speed 40km/hr. PT mode share 12%, 13% increase in PT kms.	Lowest net scheme revenues due to low margins on each trip. Scheme surpluses insufficient to cover mitigation costs. NPV (20 years) $248m net scheme revenues. NPV -$257m total revenues and costs post mitigation.	$376 annual average out-of-pocket costs to impacted households (0.8% avg impacted household income). For lower income quintile (Q1-3) households, ranges from 1.1% avg income (couple 15-64) to 1.8% (1 parent family 30-49).	28% business trips are impacted (27% pay the charge). Average trip costs for those incurring the charge increases 41% to $9.80. No clear advantage against NZTS objectives.	Moderately complex to implement. Overall mixed congestion reduction result with significant challenges at a localised level due to high levels of diversion likely onto the local roads. Weak net revenue generation. Appears broadly possible to effectively mitigate social impacts. No clear advantage against NZTS objectives. Weak RGS alignment.
Parking Levy Scheme	Range of difficult operational implementation issues. Private property issues escalate legislative challenges. Total scheme capex $12m NPV.	Relatively modest reductions in congestion across Auckland isthmus area. 18% congested VKT, average network speed 42km/hr PT mode share 14%, 28% increase in PT kms.	Similar scheme net revenues to Single Cordon. Low mitigation costs results in good post mitigation surpluses. NPV (20 years) $471m net scheme revenues. NPV $461m total revenues and costs post mitigation.	$1,487 annual average out-of-pocket costs to impacted households (3% avg impacted household income). For lower income quintile (Q1-3) households, ranges from 5.6% avg income (couple 15-64 yrs) to 10.8% (1 parent family 30-49 yrs).	N/A (business trips not impacted under current modelling assumptions for this scheme). No clear advantage against Economic Development, Public Health and Energy Efficiency objectives. Overall mildly positive assessment against other NZTS objectives including Access & Mobility, Safety and Environmental Sustainability.	Serious concerns regarding operational implementability and related enforcement costs. Not very effective at reducing congestion. Good financial viability due to low collection and mitigation costs. Appears broadly possible to effectively mitigate social impacts. Mildly positive NZTS assessment. Weak alignment with the RGS.

156. Overall, the results suggest that:

- The **Single Cordon scheme** would be the easiest to implement from a technical perspective and also shows good congestion benefits across a range of indicators. Due to the cordon location being essentially a ring around the Auckland isthmus, the extent of adverse diversion impacts is less than under the Area scheme (primarily because there are no alternative routes). Cash flows are reasonably strong, but 25-30% less than those generated by the Area and Double Cordon schemes and not sufficient to cover mitigation costs. Social impacts are difficult to mitigate effectively for this scheme due to the cordon effectively 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.
- The **Double Cordon scheme** is the next easiest to implement, although the requirement to also toll trips across the inner cordon and along SH20 adds a degree of complexity. This scheme provides the best overall congestion benefits across a range of indicators but does not encourage a shift to other modes as well as the Area scheme. There are some diversion effects along SH20 and along the perimeter of the inner cordon (the latter being similar to the Area scheme). Social impacts are difficult to effectively mitigate for this scheme for similar reasons to the Single Cordon with the added complexity of an inner cordon. Cash flows are very strong and meet the costs of mitigation measures proposed.
- The **Area scheme** generates strong cash flows and shows good congestion results across a range of indicators, particularly switching to public transport. However, it will be necessary to mitigate against the diversion to certain ring roads around the boundary of the Area. Social impacts are largely able to be mitigated for this scheme as fewer high social deprivation households are impacted than with the Cordon schemes. Access and mobility challenges are reduced by the focus on the CBD, which has good public transport access, with required improvements being relatively straightforward. This scheme has the largest impact on business trips.
- The **Strategic Network Charging** scheme has minimal adverse social impacts compared with the other schemes. Its main drawback is the diversion impact of traffic onto the local road network. Furthermore, because charges have been set "low" to minimise this impact, the Strategic Network Charging scheme also fails to generate strongly positive net cash flows and consequently raises insufficient revenues to fund mitigation strategies, primarily in the form of enhanced local road capacity.
- The **Parking Levy** scheme produces modest congestion reduction results. Financial results are reasonably good due to 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 are no significant adverse impacts on businesses and it appears that impacts on households can largely be mitigated.

Glossary

Term	Definition
2016 No Pricing RART model	Refer Base Case
AHB	Auckland Harbour Bridge
Air Shed	Volume of air bounded by geographical and/or meteorological constraints
AM Peak	7-9am, for the purpose of the RART model but 6-10am as the charging period considered for this study
Amenity	Amenity values means those natural or physical qualities and characteristics of an area that contribute to people's appreciation of its pleasantness, aesthetic coherence, and cultural and recreational attributes
ANPR	Automatic Number Plate Recognition
Area scheme	Charging vehicles entering or travelling within a defined area
ARPES	Auckland Road Pricing Evaluation Study
ART	Auckland Regional Transport (model)
Base case	Represents the combination of roads, passenger transport services and other traffic and demand management activities that represents likely transport conditions without a road pricing intervention
BCR	Benefit-Cost Ratio
Capex	Capital expenditure
CBD	Central Business District
CV	Commercial vehicle
Deprivation index	Index combining a range of key socio-demographic factors from the 2001 Census and estimates an overall score of material and social deprivation for a particular area, on a scale of 1 (least deprived) to 10 (most deprived or experiencing considerable hardship)
Double Cordon scheme	Charging vehicles, on entry, that cross either of two cordon rings. Charges do not apply to travel entirely within the inner cordon
DSRC	Dedicated Short Range Communications
Free-flow tolling	Tolling systems which do not require drivers to slow or stop to make payment
Full Network Charging Scheme	Charging for the use (by distance) of all roads within a defined roading network
Gantries	Structure built over a road to support equipment, in particular equipment for tolling purposes
Household expenditure	Expenditure by all of the members of a household over 15; note this will include much of that spent by those under 15
integrated fares	A fare system which allows multiple trips and transfers to be made for a single fare payment
Inter-Peak	The period between the weekday AM and PM peak traffic periods
Isthmus	For the purposes of this study, Auckland City except for the Gulf Islands - see Figure 1.1
JOG	Joint Officials' Group
Level of Service	A measure of traffic conditions within each link which can be related to congestion levels, ranging from A (good) to F (bad)
LOS	Level of Service – a measure of traffic conditions which can be related to congestion levels, ranging from A (good) to F (bad)
Mode share	The proportion of total trips made on a particular transport mode
Mode shift	Shift or change from one mode of transport (PT, walk/cycle, car passenger, vehicle (car / CV)) to another
MoT	Ministry of Transport

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Term	Definition
NZTS	New Zealand Transport Strategy
Opex	Operating expenditure
OSC	Officials' Steering Committee
Parking levies	Any charge for parking on public and / or private property within a defined area - in addition to any current parking charges
Parking Levy scheme	Parking levies for parking on public and / or private property within a defined area, which may be in addition to current charges
PEM	Project Evaluation Manual
PM Peak	5-7pm for the purpose of the RART model
PT	Public transport
RART	Revised Auckland Regional Transport (model)
RGS	Regional Growth Strategy
RLTS	Regional Land Transport Strategy
Road pricing	Charging for the use of an existing road for the purpose of reducing congestion or to provide revenue for investment in land transport
Single Cordon scheme	Charging vehicles, on entry, that cross a single defined cordon. Charges do not apply to travel entirely within the cordon
strategic level model	The ART and RART models were designed to be used in the development of regional strategies and not for specific project evaluation
Strategic Network Charging scheme	charging vehicles that use motorways and major arterials roads
TDM	Travel demand management
TNZ	Transit New Zealand
Toll Lanes	Use of toll lanes on specific part of the strategic (motorway) network where this might be practical to implement
Toll Systems Project	A project to establish nationwide standards for the roadside infrastructure for tolling and the creation of a toll management system
Trip suppression	Reduction in trips made during the charging period
TSP	Toll Systems Project
Value of Time	Monetary value ascribed to individuals' time based on stated preference survey data
VKT	Vehicle kilometres travelled
VOC	Vehicle Operating Cost
VoT	Value of Time
Western Ring Route	Current and planned State Highway corridor between Albany and Manukau via SH 18, SH16 and SH 20

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