

The Congestion Question

Could road pricing improve Auckland's traffic?

Workstream 3

Shortlist evaluation

May 2019

Working draft vE



New Zealand Government

Table of contents

1	Introduction	1
2	Main findings	2
3	Recommendations	3
4	Shortlist evaluation process	3
5	Network performance	4
5.1	Methodology	4
5.2	Evaluation findings	6
6	Social assessment	7
6.1	Methodology	7
6.2	Evaluation findings	7
6.3	Limitations	8
7	Practical assessment	9
7.1	Methodology	9
7.2	Evaluation findings	9
8	Preliminary cost benefit analysis (CBA)	11
	Appendix A: Detailed analysis	13



1 Introduction

Phase II of The Congestion Question (TCQ) project involved developing a longlist of pricing and non-pricing options, with the potential to reduce congestion and improve network performance. In February 2018, a multi-criteria assessment was conducted on the options longlist to determine the shortlist options that would be developed further for detailed modelling and subsequent analysis. The results of that evaluation were presented to the TCQ Governance Group in May 2018, where the shortlisted options were identified and agreed. The five options in the shortlist are:

- **City Centre Cordon** – vehicles are charged to enter/exit the city centre (in the peak direction)
- **Isthmus Area** – vehicles are charged to enter/exit and travel within the Auckland isthmus during congested periods
- **Target Congested Corridors** – vehicles are charged (on a per km basis) to travel on congested corridors during congested periods (*also referred to as the “Strategic Corridors” option*)
- **Combination** (City Centre Cordon and Target Congested Corridors) – vehicles pay for the distance travelled on congested corridors, and also to enter/exit the city centre during congested periods
- **Regional Network** – vehicles are charged (on a per km basis) to travel on all congested roads during congested periods. This option requires all vehicles to install GPS/cellular in-vehicle hardware (on-board units (OBUs)).

Following detailed modelling and analysis, the shortlisted options were evaluated against the following criteria, which reflect the project’s Terms of Reference (ToR):

- Impact on network performance
- Social impacts
- Practical attributes and limitations
- Costs and benefits.

This paper gives an overview of the methodologies and findings from the shortlist evaluation process.



New Zealand Government

2 Main findings

1. The City Centre Cordon covers a small area and has a limited impact on overall network performance, mainly targeting home to work (commuting) trips. Small scale and proven technology translates into low technical, implementation, operating, and privacy risks. Equity impacts are likely to be modest because of the small number of trips impacted and wide availability of public transport alternatives to and from the city centre. For these reasons, along with its comparability to international schemes and potential for public acceptability, this option presents a potential low-risk starting point for introducing congestion pricing.
2. The Isthmus Area option impacts the largest number of vehicle trips, but targets trips based on geography rather than contribution to congestion. Accordingly, the impacts on network performance are not as good as those achieved by the Strategic Corridor, Combination or Regional Network options, where a much lower reduction in trips generates greater reductions in congestion. Additionally, spatial and equity impacts are worse for the Isthmus Area option as households within the isthmus Local Board areas bear the large brunt of the scheme.
3. The Strategic Corridors option is targeted and generates meaningful, region-wide network performance benefits and congestion relief. The option has low technical implementation and operating risks because it is relatively simple to develop, operate and manage. There are limited privacy concerns (similar to the City Centre Cordon) because it only requires the collection of ANPR image data to match vehicles with charging locations. The estimated average change in financial costs for households are broadly similar by location, and spatial impacts are low because the scheme targets congested routes not boundaries. This means there is less disparity between different spatial areas of Auckland.
4. The Combination option generates very similar (positive) impacts to the Strategic Corridors option. There is no clear reason why the Combination option would be preferred to the Strategic Corridors option as there are no meaningful additional benefits from considering the two options as a combined package. That said, there are also no observed detrimental effects when compared to the Strategic Corridors option. Therefore the two individual options will be progressed separately, as the potential to stage the implementation of both is viable (likely the City Centre Cordon followed by Strategic Corridors).
5. The Regional Network option achieves only a small incremental improvement to network performance over the Strategic Corridors option, but has the lowest benefit-cost ratio because of high capital and operating costs. The requirement to install in-vehicle units capable of collecting time and location data for ALL trips including uncharged road segments raises significant privacy and acceptability concerns. With no international precedent, the scheme has the highest technical risk of all the options considered. Poor equity outcomes stem from significant financial impacts for all household types (partially associated with the costs of the in-vehicle units), with low income households disproportionately affected. As this option is appealing due to its high level of flexibility, this option may become considerably more cost effective and lower risk as technology evolves over time and could be revisited in the future.



3 Recommendations

Based on the main findings outlined above it is recommended that the City Centre Cordon and Strategic Corridors options are taken forward for further detailed investigation and analysis. The next step for Phase II of the TCQ project is to undertake a detailed planning exercise to scope the activities required to refine these two options.

It is not proposed that the other options (Isthmus Area, Combination and Regional Network) are further developed at this time.

4 Shortlist evaluation process

The ToR for The Congestion Question project specify that the investigation into any pricing option must give consideration to the following areas:

- Improving the performance of Auckland’s transport network, in particular through improved congestion results (network performance)
- The economic, social and environmental effects including fairness, equity and distributional impacts (social assessment)
- Cost-effectiveness of implementation, operation, administration and enforcement (practical assessment).
- Flexibility and adaptability of pricing (tariff policy).

In order to conduct a thorough and meaningful evaluation of the five shortlist options against the areas above, a significant amount of modelling, analysis and research was necessary. This was undertaken by specialist organisations as follows:

1. The Auckland Forecasting Centre (AFC) modelled the five scheme options with the Auckland Macro Strategic Model (MSM) so the impacts of each option on network performance could be interpreted.
2. Covic and MRCagney built a bespoke model using MSM outputs and Statistics NZ data, and prepared the analysis of the social and distributional impacts of each option.
3. D’Artagnan Consulting assessed the practical attributes and limitations of each option based on international experience and industry benchmarking, including capital and operating cost estimates.
4. PwC built a cost-benefit analysis (CBA) model following NZTA’s Economic Evaluation Manual (EEM) guidelines (using outputs from the above processes).

Using the outputs from the modelling, analysis and research, the evaluation took place as a series of workshops in mid-November 2018 which were attended by the project working group and the relevant specialists, who were available to present their analyses at the respective sessions. Due to the nature of the shortlisted options, both a quantitative and qualitative approach to evaluation of the shortlist options was undertaken by the project working group.



5 Network performance

5.1 Methodology

The modelling conducted by AFC was the first stage in the shortlist assessment as outputs from this were required to feed into the social, practical and CBA assessment activities. The baseline scenario (or base case) in the model was set at 2028, which assumes the improvements committed in the Regional Land Transport Plan (RLTP) have been made to the transport network. Attributes of each option were then modelled and the resultant network impacts were captured. The modelling followed an iterative process, with the tariff and per kilometre charges being adjusted several times. Final tariff values modelled were \$2.30 for the cordon/area schemes and \$0.12 / km for distance based schemes (corridors/network).

Key metrics from the modelling (based on the 2028 morning peak only) were used to compare the five options and observe the relative impact of each option on the network compared to the baseline. Results are shown in Table 1.

TABLE 1: NETWORK PERFORMANCE MODELLING RESULTS

	City Centre Cordon		Isthmus Area		Strategic Corridors		Combination		Regional Network	
	Value	%	Value	%	Value	%	Value	%	Value	%
Number of vehicle trips reduces by:	2,489	0.4%	29,898	4.7%	8,317	1.3%	10,613	1.7%	13,995	2.2%
Average vehicle travel time reduces by:	-	0.8%	-	5.4%	-	6.7%	-	7.6%	-	8.2%
Total travel time delay (compared with efficient conditions) reduces by:	1,514 hrs	4.2%	9,280 hrs	26%	10,857 hrs	30.4%	12,369 hrs	34.6%	11,726 hrs	32.8%
Time spent in severe congestion reduces by:	-	2.5%	-	13.8%	-	16.1%	-	19.0%	-	20.3%
Freight vkt in severe congestion on the strategic freight network reduces by:	-	1.6%	-	10.7%	-	22.4%	-	25.7%	-	23.9%
Number of public transport trips increases by:	619	0.5%	4,129	3.1%	1,221	0.9%	2,022	1.5%	1,807	1.3%
Number of jobs accessible within a 30 minute drive increases by:	5,463	1.9%	50,369	17.9%	40,955	14.6%	53,232	18.9%	48,094	17.1%
Annual revenue	\$21m	-	\$259m	-	\$205m	-	\$223m	-	\$261m	-

Table 1 reflects the modelled change in the morning peak only. This does not report the full picture of changes that are occurring, for example trips that change the time of day they are occurring. This is the main reason¹ why there is still a difference when comparing the reduction in number of vehicle trips with the increase in public transport trips.

Considering each metric individually gives an indication of each option's performance when compared with all the other options. Figures 1 – 7 illustrate the relative performance of each option against the baseline and against each other, for various key metrics².

¹ Note that some trips will simply no longer occur at all.

² The impact on public transport trips has been omitted from the graphical comparison.



New Zealand Government

FIGURE 1

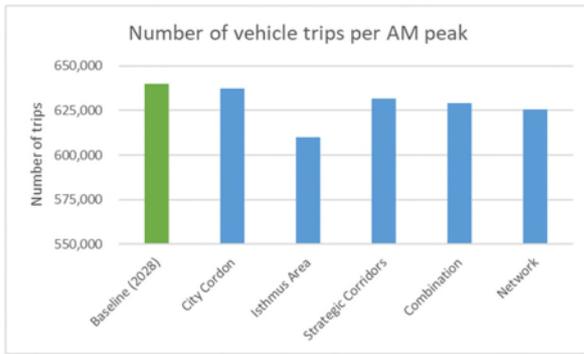


FIGURE 2

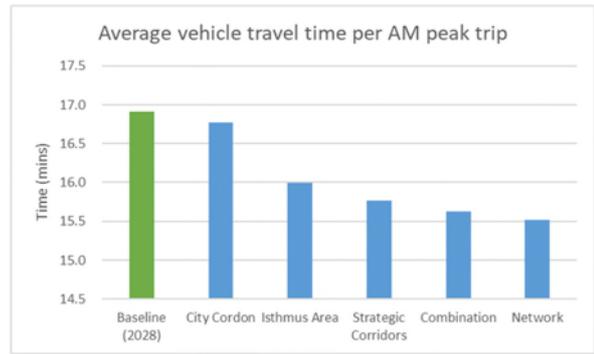


FIGURE 3

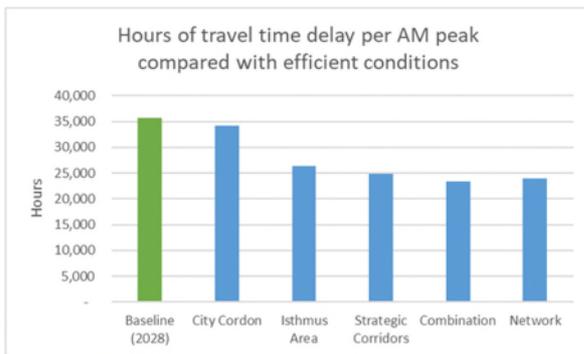


FIGURE 4

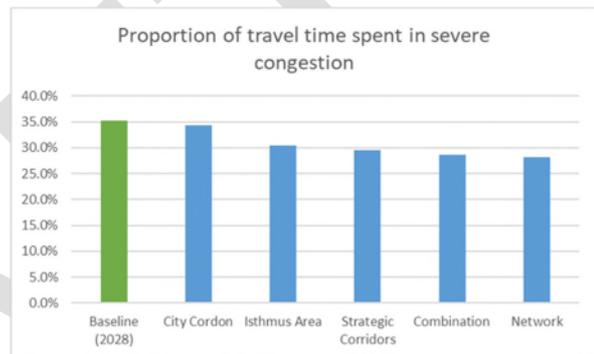


FIGURE 5

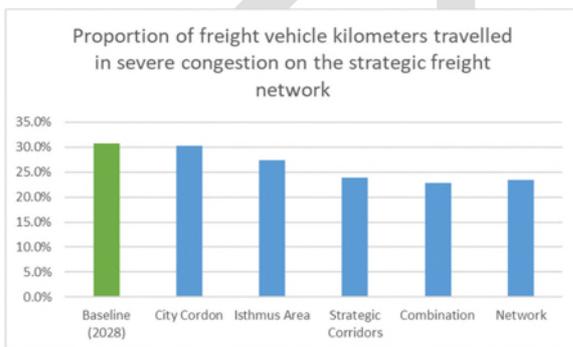


FIGURE 6

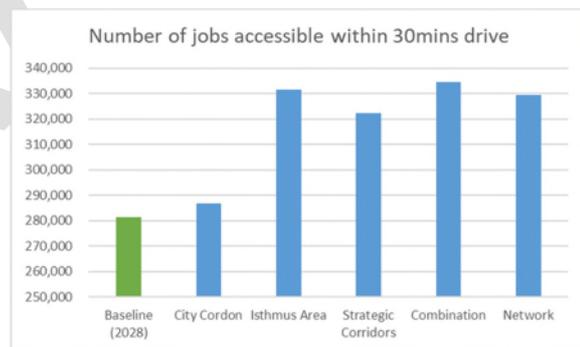
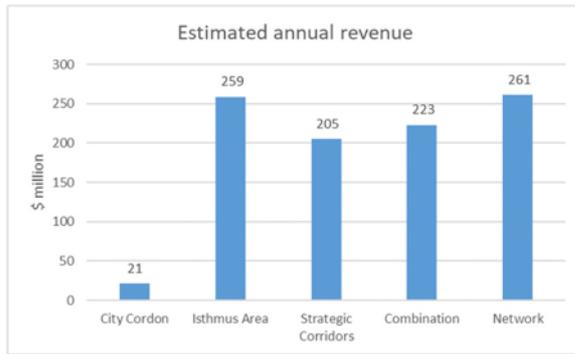


FIGURE 7



5.2 Evaluation findings

1. City Centre Cordon covers a small area and has a limited impact on overall network performance as shown by the small reductions in Table 1, mainly targeting home to work trips.
2. The Isthmus Area option has the largest reduction in number of vehicle trips, but less impact on network performance than the Strategic Corridors, Combination and Regional Network options (as shown in the comparison of travel time, travel time delay and time spent in severe congestion metrics).
3. The Isthmus Area option disproportionately impacts short trips, regardless of trip purpose and contribution to congestion (as the same charge applies regardless of trip length). This suggests it is less effective as the network performance benefits are disproportionately small when compared with the number of affected trips.
4. The Strategic Corridors option is targeted and generates meaningful, region-wide network performance benefits and congestion relief.
5. The Strategic Corridors and Combination options have similar impacts in terms of network performance, with small additional improvements to network performance observed in the Combination option due to the addition of the City Centre Cordon (ie the effects are additive).
6. The Regional Network option achieves similar network performance outcomes to both the Strategic Corridors and Combination options, and does not offer any noticeable additional congestion relief or network performance benefits.
7. None of the options show a significant increase in PT mode share. This is consistent with international evidence of a relatively small mode shift to PT following the introduction of congestion charging (noting there is a significant uplift in the 2028 baseline over current PT mode share). Also, at this stage, the provision of additional PT routes or services to complement congestion pricing have not been included in the modelling undertaken.

Note: The potential for diversion or ‘rat-running’ is an important consideration. The transport modelling is somewhat constrained in that it does not include every street (as it is a regional strategic model). It therefore will not give a detailed representation of diversions that some drivers may make in an attempt to avoid a congestion charge. The next stage of options analysis and detailed design will take this consideration into account and potential mitigations include enforcement measures, detailed scheme design or tariff policy.



6 Social assessment

6.1 Methodology

International review has found that abandoned schemes have arguably failed due to an inability to articulate a satisfactory response to concerns about equity impacts. The goal of TCQ is to design a scheme that is effective in terms of network performance, practical to implement and avoids significant negative social impacts.

Congestion pricing and the resulting incidence of benefits and costs, can impact different household, business and geographic groups in different ways depending on the circumstances. Fairness in the context of congestion pricing has a number of dimensions:

- Vertical Equity - How benefits and costs are distributed across income groups, including the impacts from expenditure funded by congestion pricing revenue.
- Horizontal Equity - How benefits and costs are distributed across similar groups of users, households, and communities. Ideally 'like should be treated alike'.
- Spatial Equity - How benefits and costs for households and businesses are distributed across geographical areas. How does congestion charging affect different areas and does it have an impact on access, social inclusion and inclusiveness?

The social assessment is a spatially based model which uses Statistics NZ data, and outputs from the MSM runs to estimate impacts on households from congestion pricing. Specifically:

- Baseline travel patterns and trip costs allocated to different household types
- Households allocated to three income bands for each of the Local Board Areas in Auckland
- Different household travel responses used to assess impact of congestion pricing across the Auckland region for the five shortlist options.

The social assessment will also be used to improve scheme design to reduce the number of households negatively impacted and highlight the potential trade-offs between alternative scheme designs, social impacts and mitigation measures.

6.2 Evaluation findings

1. In line with international evidence, all the short-list options generate higher absolute costs for high-income households, but higher costs as a percentage of income for low income households.
2. Business impacts are generally positive because overall travel costs decline.
3. Overall financial and spatial impacts of the City Centre Cordon are likely to be modest because of the small number of trips impacted and wide availability of public transport alternatives.
4. The Isthmus Area option results in disproportionate financial impact on Isthmus based households, and the location of the charging boundary is likely to generate community and cultural severance.
5. Estimated average change in costs for households are broadly similar by location for the Strategic Corridors option. As the scheme targets congested routes not geographical boundaries, this means there is less disparity between different spatial areas of Auckland.



New Zealand Government

6. Estimated impacts for the Combination option are in line with the Strategic Corridors scheme, but the addition of the cordon charge generates higher financial impacts for city centre bound trips.
7. The Regional Network scheme generates significant financial impacts for all household types, with low income households disproportionately affected due to the requirement and costs to install and operate in-vehicle hardware.

Further detail of the methodology applied and outputs from the social assessment are explained in the report from Covec and MRCagney titled *“Congestion Pricing Options for Auckland: Analysis of distributional effects”*.

6.3 Limitations

The social assessment is highly complex and a number of gaps were highlighted through the process where additional effort will be focused in subsequent stages to increase the understanding of the impacts with more granularity. The analysis is in part limited by the level of disaggregation in the information that is available (such as household income and travel pattern data) and certain assumptions that need to be made. In subsequent stages we will look to supplement the available datasets with additional observed information to enhance the social assessment activities.



7 Practical assessment

7.1 Methodology

For the practical assessment, each shortlisted option was reviewed against five criteria:

1. Flexibility
2. Enforcement
3. Privacy
4. Risks
5. Capital and operating costs.

Flexibility examined whether:

- the scheme was scalable
- charges could be practically or easily varied by location, time of day or direction of travel
- frequent and infrequent users could be accommodated
- the scheme could accommodate changes in technology, delivery options and long-term national policy changes.

The assessment of **enforceability** of each option examined:

- the technical ease of enforcement and resilience of approaches to expansion/changes
- the relative enforcement costs of each scheme, infrastructure required, operating costs and publicity
- public acceptability due to intrusiveness
- risks of unintentional non-compliance due to complexity
- risks of intentional non-compliance/fraud due to opportunity or disenchantment.

Privacy was assessed based on the ease by which the option could protect individual user privacy, particularly regarding the amount of trip data collected.

The primary risk to the success of a congestion pricing scheme is lack of public acceptability. In addition to public acceptability, the **risks** associated with technical implementation, operations and impacts (eg insufficient behavioural response) were considered for each option.

Capital expenditure required to set up each option and the **operating costs** of each option were estimated based on knowledge of other schemes operating around the world. These cost estimates, along with revenue data from the MSM, were used in the subsequent cost-benefit analysis.

7.2 Evaluation findings

1. Strategic Corridors and Regional Network schemes are the most scalable. City Centre Cordon and Isthmus Area schemes have low scope for scaling as standalone schemes without negative impacts, however they could evolve by having another option added at a later date. The Strategic Corridors scheme could be piloted on a small scale and expanded incrementally.



2. The Isthmus Area scheme is the least flexible overall (single charge within a set period for all movements in an area); Strategic Corridors option is the most flexible (can be expanded, varied and accommodate all user types).
3. The Regional Network option's flexibility is limited by the need for OBUs and a parallel ANPR system for enforcement and visitors/occasional users.
4. Cost and complexity of enforcing City Centre Cordon and Strategic Corridors schemes would be lowest because chargeable events are simple to detect (matching a number plate to a location).
5. Enforcement of Isthmus Area and Regional Network schemes is more complex and costly due to the requirement for extensive ANPR roadside infrastructure (extent of coverage would depend on compliance requirements/target).
6. Privacy protections are required for all options, but the City Centre Cordon, Isthmus Area and Strategic Corridors schemes are only required to collect ANPR image data to match a vehicle with the charging station.
7. The Regional Network scheme raises significant privacy concerns because in-vehicle units collect time and location data for ALL trips, including uncharged road segments.
8. ANPR technology is low risk, as it is a well-proven technology that is cost effective.
9. Technical implementation and operating risks are lowest for the City Centre Cordon and Strategic Corridors options, because they are relatively simple to operate and manage.
10. Highest risks are for the Regional Network and Isthmus Area schemes. There are no international precedents for a large area scheme or a congestion scheme that has deployed GPS in-vehicle hardware for light vehicles.

Further detail of the methodology applied and outputs from the practical assessment are explained in the report from D'Artagnan Consulting titled "*Advanced Technical Review*".



New Zealand Government

8 Preliminary cost benefit analysis (CBA)

A preliminary CBA has been undertaken as part of the short list evaluation to be considered along with the findings from the network performance, social and practical assessments. There are a number of limitations to this preliminary CBA, and this is one reason why the overall evaluation requires all four evaluation aspects to be considered in determining the overall findings and any subsequent recommendations. The aim of congestion charging is not limited to generating the highest benefits (or BCR), as noted in the Terms of Reference that highlight the importance of considering the other factors. For example, imposing a higher tariff would generate higher travel time and reliability benefits (through greater improvements to network performance), but have significantly greater negative social impacts.

The estimated cost of each of the shortlisted option is displayed in Table 2. Periodic opex relates to the renewal of systems and infrastructure every 7 years. The Regional Network option has significantly higher costs associated with it due to the OBU requirements as discussed in the previous section.

TABLE 2: CAPEX AND OPEX FOR EACH SHORTLIST OPTION (\$M)

	City Centre Cordon	Isthmus Area	Strategic Corridors	Combination	Regional Network
Capex	46.0	198.0	185.0	207.0	579.0
Annual Opex	10.0	57.0	84.0	87.0	267.0
Periodic Opex	13.8	59.4	55.5	62.1	173.7

Source: D'Artagnan Consulting

The annual benefits for each option are detailed in Table 3. Benefit calculations are consistent with the Transport Agency's Economic Evaluation Manual (EEM) methods and revenue is excluded from the analysis. Environmental impacts were monetised by calculating the savings from estimated reductions in harmful emissions that each option would bring about.

The actual economic benefits of the schemes would be higher when wider factors, such as wider economic benefits, labour supply impacts, improved productivity and liveability, (outside the scope of a traditional EEM assessment) are incorporated.

TABLE 3: ANNUAL BENEFITS (\$M)

	City Centre Cordon	Isthmus Area	Strategic Corridors	Combination	Regional Network
Travel time	17.9	114.6	107.8	124.8	138.7
Increased reliability	3.1	20.6	17.9	20.9	23.1
Congested travel time	3.4	20.7	24.3	27.7	26.2
Vehicle operating costs	2.3	25.2	38.4	40.4	52.1
CO2 emissions	0.2	0.4	1.3	1.1	1.3
Other emissions	0.2	0.5	1.3	1.5	1.5
TOTAL	27.2	182.1	191.0	216.4	243.1

Source: MSM outputs, TCQ analysis

The City Centre Cordon option produces only modest annual benefits, which is expected given its scale, compared to the other four options, which would be expected to generate in the order of \$200 million of benefits each year.



New Zealand Government

Taking a 23 year evaluation period (which would include implementation and then two renewals of systems and infrastructure) the CBA summary is shown in Table 4.

TABLE 4: CBA SUMMARY FOR EACH OPTION

Option	PV Benefits (\$m)	PV Costs (\$m)	NPV (\$m)	National BCR
City Centre Cordon	305.4	(181.6)	123.8	1.7
Isthmus Area	2,047.3	(936.4)	1,110.9	2.2
Strategic Corridors	2,147.6	(1,216.1)	931.5	1.8
Combination	2,433.2	(1,283.2)	1,150.1	1.9
Regional Network	2,733.7	(3,851.6)	(1,117.9)	0.7

Source: TCQ analysis

All the options generate a positive net present value (NPV) and a benefit-cost ratio (BCR) greater than 1, with the exception of the Regional Network option due to its high ongoing costs. The Isthmus Area option has the highest BCR due to slightly lower annual operating costs (compared to the Strategic Corridors or Combination options). For its size and scale, the City Centre Cordon option performs comparably to the other positive NPV options in terms of the scale of benefits relative to the costs.

A description of the steps taken to construct the CBA model are described in the paper titled “TCQ Cost Benefit Analysis (January 2019)”.

Appendix A: Detailed analysis

DRAFT



New Zealand Government



The Congestion
Question

The Congestion Question

Shortlist Evaluation Summary

SUPPORTING MATERIAL



New Zealand Government

Appendix A: Detailed Analysis

Assumptions

A: City Centre Cordon

B: Isthmus Area

C: Strategic Corridors

D: Combination

E: Regional Network

Assumptions

- Network performance is relative to 2028 baseline (with RLTP projects included).
- Network performance evaluation uses outputs for AM peak period only.
- Revenue estimates assume PM peak is also charged (ie by doubling AM peak) with no off-peak/weekend charges at this stage.
- The lowest tariff value (\$2.30 or \$0.12/km) was used for the purposes of the evaluation since previous modelling demonstrated that the relationship between tariff and congestion outcomes was non-linear, ie as the tariff was increased, there were diminishing returns in network performance.
- Charges have not been capped but that would be considered at a later stage of the project.
- Public transport capacity constraints are not included at this stage.
- Evaluation only considers congestion pricing component of the overall option (ie no complementary measures or mitigations are considered).
- Practical assessment assumes both peak periods, peak direction of flow.
- Regional Network scheme would have parallel ANPR based scheme (either area charge or corridor charges), to charge users who do not choose to have GNSS On Board Units installed.
- Cordon and area schemes charge any single vehicle once during a peak period, regardless of number of trips or crossings. Corridor schemes are charged per passage.
- No discounts or exemptions (but noting when these will be needed to address obvious inequities).
- No offsetting reductions in other charges/taxes (which would impact on flexibility, risk and enforcement) at this stage.

A. City Centre Cordon

Scheme features:



City Centre Cordon scheme is where vehicles are charged to enter and exit the city centre during peak travel periods:

Objective – Reduce congestion on routes leading into and across the cordon area.

Coverage – Targets vehicles passing across cordon boundaries, but not traffic circulating within the city centre. Through traffic on motorways is exempt.

Travel alternatives – Extensive PT services and high active mode share for trips to city centre.

Other - Impact is constrained by relatively small number of city centre commuter trips made by private vehicles.

A. Network Assessment: City Centre Cordon

Main Findings:

- Small coverage from a network perspective, reflected in limited improvements in network performance.
- Mainly impacts home to work trips to the city centre.
- Targets the most dense area of home to work trips in Auckland.
- Affected trips have highest access to public transport alternatives compared with other options.
- Number of trips to the city centre in the AM peak reduces by approximately 4,500.
- Unintended consequences – local impacts at the boundary of the cordon (eg increase in traffic through Ponsonby) which could be mitigated or addressed through further refinement.
- Access to employment – people who are resident just outside the city centre are negatively impacted by diverting traffic; fringe Isthmus regions (eg lower North Shore/Te Atatu/Mangere) have improved accessibility through number of jobs they can access within a 30min drive.

A. Practical Assessment: City Centre Cordon

Main Findings:

Flexibility - low scope for scaling without negative impacts; too small to have more refined charges (disaggregation of charges); able to accommodate wide range of users; small scheme, little scope for flexibility but can have other schemes added relatively easily.

Enforcement - cost and complexity of enforcing cordon would be low as chargeable events simple to detect; enforcement approach likely to be similar to tolls.

Privacy - large volumes of ANPR collected, important for public acceptability to limit use of that data for scheme purposes; only need to retain data to ensure payment is made for a trip; exact location data not required since charge not varied by location.

Risk - public acceptability is likely to be a lower risk with City Centre Cordon; technical implementation and operating risks low as scheme is relatively simple to operate.

Cost – Capex \$46m; Annual opex \$10m

A. Social Assessment: City Centre Cordon

Main Findings:

- The small scale of this option means the analysis of equity impacts is problematic.
- The estimated change in financial costs for households across the Auckland region is insignificant because of the small number of trips impacted.
- There are reductions in car trips, particularly for trips to work or education, and increases in PT trips.
- High income households reduce car trips less than low income households.
- Car trip reductions (and PT increases) are greater for larger households.
- Overall equity impacts likely to be modest, supported by wide availability of PT alternatives.

B. Isthmus Area

Scheme features:



Isthmus Area scheme is where vehicles are charged to enter, exit and travel within the urban area defined by the Auckland Isthmus.

Objective – Reduce congestion on routes leading into, across and within the Isthmus Area.

Coverage – Targets vehicles passing across Isthmus boundaries, and circulating within the Isthmus Area.

Travel alternatives – Generally good availability of PT services on main routes.

Other – Will capture large number of resident workers travelling within the Isthmus Area.

B. Network Assessment: Isthmus Area

Main Findings:

- Isthmus Area covers a geographical zone that has similar numbers of jobs and residents and is not as targeted to areas of severe congestion as other options.
- The number of vehicle trips decreases by 4.7% (the highest of all scheme options) but corresponding congestion outcomes are not as significant as for Strategic Corridors, Combination and Regional Network options.
- Average trip length increases by 2.1% (highest of all options) because charge represents a higher proportion of total trip costs for short trips.
- This option shows the largest shift to PT as the Isthmus is well served.
- Generates the highest revenue.
- Unintended consequences – rather than a diversion effect there are boundary effects of area schemes (eg more vehicle trips made just before/just after the charging period - temporal boundary effect or more vehicle trips made outside the charged zone – spatial boundary effect).
- Accessibility – general improvement observed in access to jobs within the Isthmus and adjacent areas due to removal of circa 30,000 trips.
- Not as effective in supporting congestion improvements on the freight network as Strategic Corridors, Combination or Regional Network options – due to less coverage of strategic freight network.

B. Practical Assessment: Isthmus Area

Main Findings:

Flexibility - low scope for scaling without negative impacts; area charge too simple to charge flexibly; least flexible overall (single charge within a set period for all movements).

Enforcement - expensive/complex to enforce due to need for camera coverage of a large area (incl mobile cameras); enforcement likely to be perceived as blunt and intrusive.

Privacy - large volumes of ANPR collected, important for public acceptability to limit use of that data for scheme purposes; only need to retain data to ensure payment is made for a trip; exact location data not required since charge not varied by location.

Risk – public acceptability risk high; technical and operating risk high; equity risk high.

Cost – Capex \$198m; Annual opex \$57m

B. Social Assessment: Isthmus Area

Main Findings:

- The estimated reduction in car trips is much more significant than for the Central City Cordon option.
- High income households are reducing car trips and increasing PT trips less than low income households. Changes in PT trips are broadly similar across income categories once household attributes are considered.
- The changes in trip numbers differ significantly by location, with isthmus suburbs show more significant AM peak trip reductions, with a 37% reduction in car trips for Albert-Eden compared with 0.4% for Franklin.
- The change in costs for households also differs significantly by location for all household types with the widest range recorded for low income households. To illustrate, the increase in trip costs for low income households as a percentage of income ranging from 0.14% for Manurewa to 2.07% for Maungakiekie-Tamaki.
- Across the region, the average increase in trips costs for high income households was \$296 per annum representing an increase of 0.19% as a percentage of income. For low income households the corresponding figures were \$201 and 0.67% respectively.
- Poor spatial equity arises from disproportionate financial impact on Isthmus based households.
- Location of charging boundary likely to generate community and cultural severance impacts.

C. Network Assessment: Strategic Corridors

Scheme features:



Strategic Corridors scheme is where vehicles are charged to travel on Auckland's strategic and arterial network in the links contained in Auckland region:

Objective – Reduce congestion on SH and arterial routes.

Coverage – Targets commuters travelling on 220km SH and main arterial road network across Auckland region.

Travel alternatives – Main arterials generally characterised by availability of PT services.

Other – May encourage some diversion onto suburban road network, however many arterial links characterised by monopolistic qualities.

C. Network Assessment: Strategic Corridors

Main Findings:

- A modest reduction in vehicle trips (1.3% reduction) gives positive congestion outcomes.
- Better at targeting areas of severe congestion – seen through bigger improvements in network performance metrics than City Centre Cordon and Isthmus Area options.
- Meaningful reduction in average travel time (6.7%).
- Strategic Corridors almost achieves same performance as Regional Network option, but with not nearly the same amount of coverage – suggesting negligible additional network benefits from the Regional Network option.
- Unintended consequences – an increase in congestion on some suburban roads where diversions occur.
- Accessibility - general improvement observed in access to jobs in the wider Auckland region.
- Time spent in severe congestion by freight trips reduces by 22%.

C. Practical Assessment: Strategic Corridors

Main Findings:

Flexibility – large scope for scaling; could be piloted on a small scale and expanded incrementally; easy to disaggregate; able to accommodate wide range of users; could evolve to a regional network scheme over time.

Enforcement - cost and complexity of enforcing cordon would be low as chargeable events simple to detect; enforcement approach likely to be similar to tolls.

Privacy - large volumes of ANPR collected, important for public acceptability to limit use of that data for scheme purposes; only need to retain data to ensure payment is made for a trip; exact location data would need to be collected to calculate charge.

Risk - public acceptability is likely to be a lower risk with City Centre Cordon; technical implementation and operating risks low as scheme is relatively simple to operate.

Cost – Capex \$185m; Annual opex \$84m

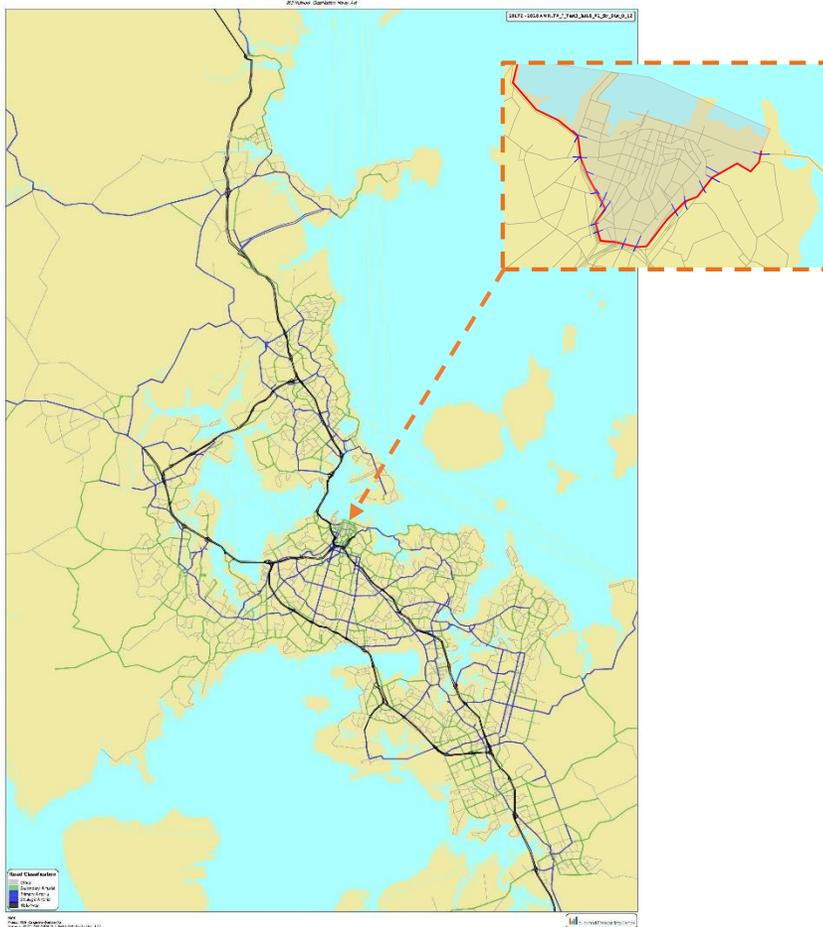
C. Social Assessment: Strategic Corridors

Main Findings:

- The estimated reduction in car trips is widely dispersed throughout the Auckland region.
- In line with the Isthmus Area scheme, high income households reduce car trips less than low income households. Changes in PT trips are broadly similar across income categories once household attributes are considered.
- The changes in trip numbers by location are broadly similar, with most suburbs predicted to experience a 6.0-8.0% reduction in AM peak trips.
- The estimated change in costs for households is broadly similar by location, with the increase in trip costs for low income households as a percentage of income ranging from 0.22% for Albert-Eden to 1.04% for Upper Harbour.
- Across the region, the average increase in trips costs for high income households was \$230 per annum representing an increase of 0.15% as a percentage of income. For low income households the corresponding figures were \$156 and 0.52% respectively.
- Spatial impacts are modest because scheme targets congested routes as opposed to geographical boundaries.
- Absence of cordons likely to minimise community and cultural severance impacts.

D. Network Assessment: Combination

Scheme features:



Strategic Corridors and City Centre Cordon scheme is where vehicles are charged to travel on the strategic network and travel into and out of the city centre.

Objective – Reduce congestion on strategic routes and discourage peak period trips to and from the city centre.

Coverage – Targets trips travelling on all strategic links and vehicle travel to and from the city centre.

Travel alternatives – City centre routes and main arterials generally characterised by availability of PT services.

Other – Scheme aims to suppress vehicle travel in city centre and capture dispersed peak period trips across Auckland region.

D. Network Assessment – Combination

Main Findings:

- Network performance of Combination option is almost additive between City Centre Cordon and Strategic Corridors options.
- A modest reduction in vehicle trips (1.7% reduction) gives positive congestion outcomes.
- Better at targeting areas of severe congestion – seen through bigger improvements in network performance metrics than City Centre Cordon and Isthmus Area options.
- Meaningful reduction in average travel time (7.6%).
- Combination option achieves better overall performance than the Regional Network option, with less coverage – suggesting no additional benefits from the Regional Network option.
- Unintended consequences – an increase in congestion on some suburban roads where diversions occur.
- Accessibility - general improvement observed in access to jobs in the wider Auckland region.
- Time spent in severe congestion by freight trips reduces by 26%.

D. Practical Assessment: Combination

Main Findings:

As per Strategic Corridors option

Cost – Capex \$207m; Annual opex \$87m

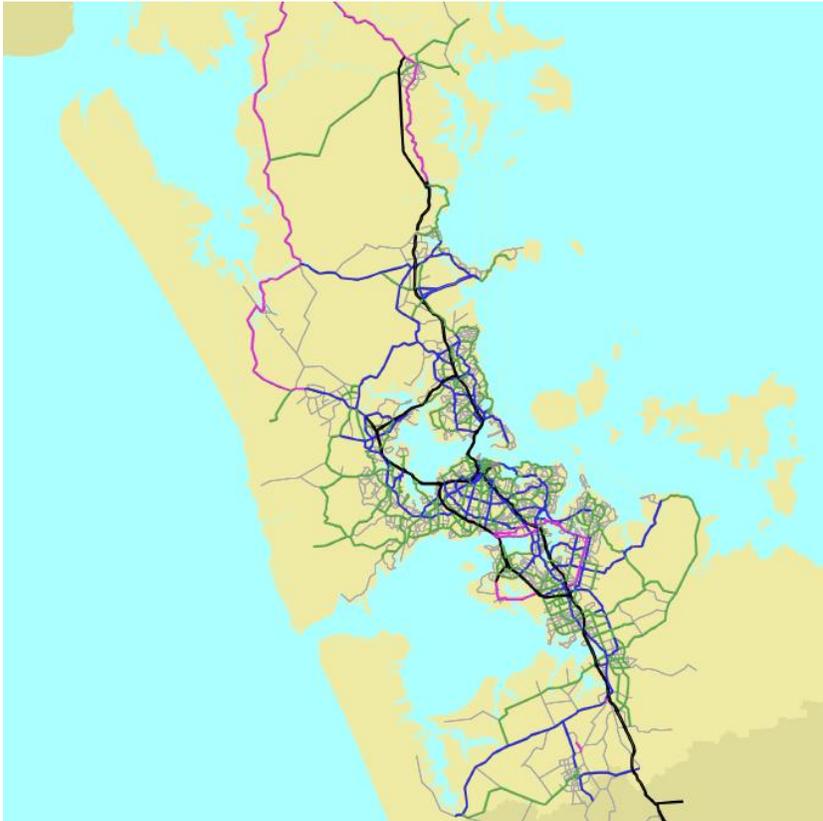
D. Social Assessment: Combination

Main Findings:

- The estimated reduction in car trips is widely dispersed throughout the Auckland region in line with the Strategic Corridors option.
- In line with the other schemes, high income households reduce car trips less than low income households. Changes in PT trips are broadly similar across income categories once household attributes are considered.
- The changes in trip numbers by location are broadly similar, with most suburbs predicted to experience an 8.0-10.0% reduction in AM peak trips.
- The estimated change in costs for households is broadly similar by location, with the increase in trip costs for low income households as a percentage of income ranging from 0.25% for Albert-Eden to 1.13% for Upper Harbour.
- Across the region, the average increase in trips costs for high income households was \$258 per annum representing an increase of 0.16% as a percentage of income. For low income households the corresponding figures were \$176 and 0.59% respectively.
- Spatial impacts are modest in-line with Strategic Corridors scheme, but addition of cordon charge generates higher financial impacts for city bound trips.

E. Network Assessment: Regional Network

Scheme features:



Regional Network scheme is where vehicles are charged to travel according to trip distance, time and location using in-vehicle Global Navigation Satellite System (GNSS) capable hardware.

Objective – Reduce congestion across Auckland road network.

Coverage – Scheme potentially includes entire road network noting no intention to charge on uncongested routes. Drivers are warned in advance about tariff rates and journey costs.

Travel alternatives – City centre routes and main arterials generally characterised by availability of PT services.

Technology – In-vehicle GNSS hardware and automatic number plate recognition (ANPR) used for enforcement.

Other – Vehicle identification and payment arrangements will need to be made for occasional, tourist and out-of-town travellers.

E. Network Assessment: Regional Network

Main Findings:

- A reduction in vehicle trips (2.2% reduction) gives positive congestion outcomes.
- Proportion of vehicle kilometres travelled (vkt) in severe congestion reduces significantly.
- Meaningful reduction in average travel time (8.2%).
- Impacts on network performance sit in between those delivered by the Strategic Corridors and Combination options.
- Accessibility - general improvement observed in access to jobs in the wider Auckland region, with similar improvements to the Combination option.

E. Practical Assessment: Regional Network

Main Findings:

Flexibility - large scope for scaling; easy to disaggregate; maximum flexibility but limited by need for a parallel backup scheme (ANPR cameras and in-vehicle OBUs).

Enforcement – expensive/complex to enforce, all those with in-vehicle hardware would also have ANPR images taken to match vehicles to operational OBUs; enforcement likely to be perceived as blunt and intrusive.

Privacy - large volumes of ANPR collected, important for public acceptability to limit use of that data for scheme purposes; GPS OBUs to collect ALL time and location trip data during operation so robust protocols required to protect private data collected.

Risk – public acceptability risk high; technical and operating risks high (particularly around installation and maintenance of OBUs)

Cost – Capex \$579m; Annual opex \$267m

E. Social Assessment: Regional Network

Main Findings:

- The estimated reduction in car trips is widely dispersed throughout the Auckland region.
- In line with the other comprehensive schemes, high income households reduce car trips less than high income households. Changes in PT trips are broadly similar across income categories once household attributes are considered.
- The changes in trip numbers by location are broadly similar, with most suburbs predicted to experience an 11.0-13.0% reduction in AM peak trips.
- The estimated change in costs for households is broadly similar by location, with the increase in trip costs for low income households as a percentage of income ranging from 1.29% for Waitemata to 2.28% for Upper Harbour.
- Across the region, the average increase in trips costs for high income households was \$701 per annum representing an increase of 0.45% as a percentage of income. For low income households the corresponding figures were \$530 and 1.77% respectively.
- High capital and operating costs due to the requirement to install in-vehicle hardware, generates significant financial impacts for all household types, with low income households disproportionately affected.