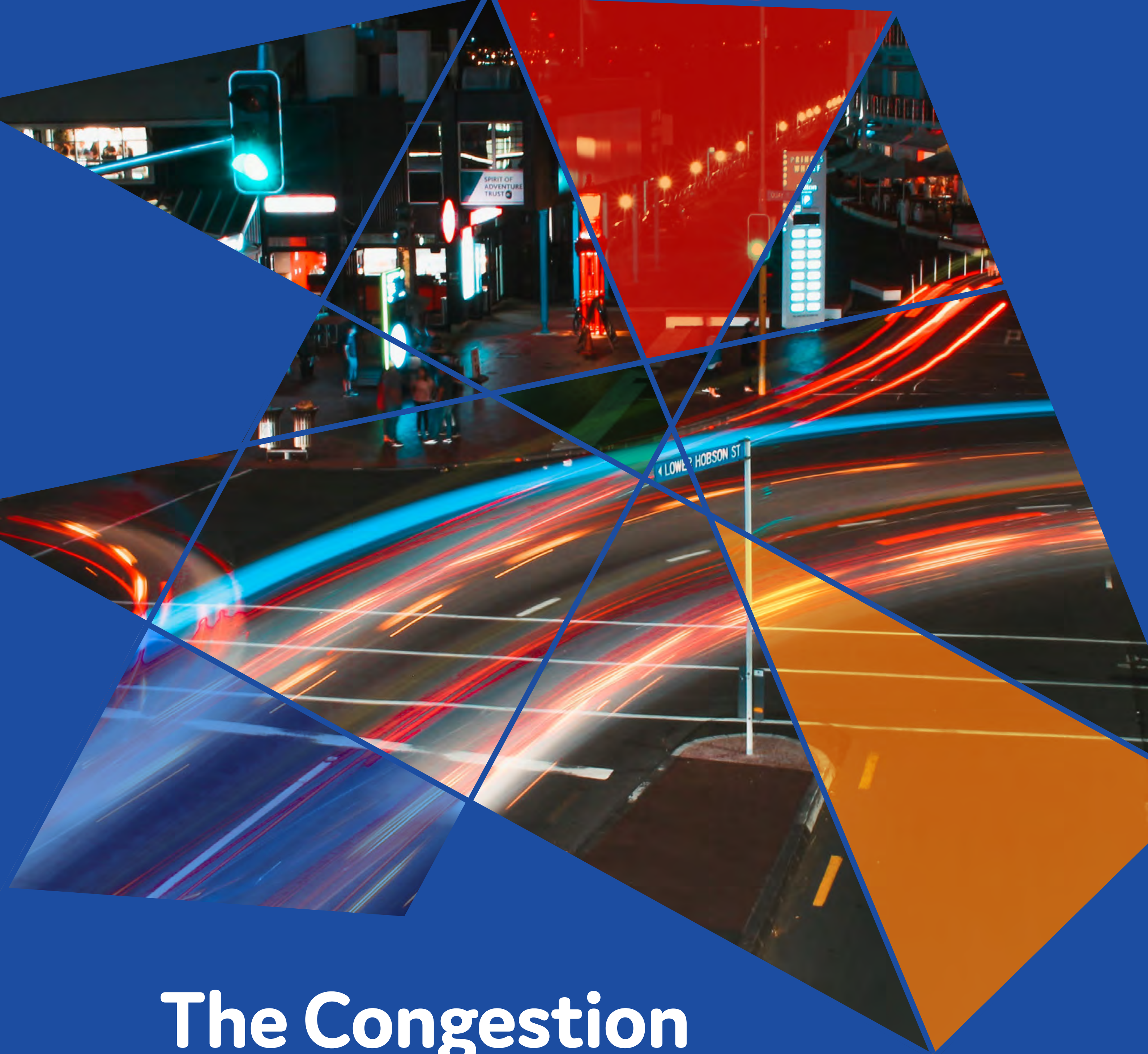


# The Congestion Question

## Technical Report

**July 2020**

Auckland Council Te Kaunihera o Tāmaki Makaurau | Waka Kotahi NZ Transport Agency | Ministry of Transport Te Manatū Waka | The Treasury Kaitohutohu Kaupapa Rawa | State Services Commission Te Komihana O Ngā Tari Kāwanatanga | New Zealand Government

# Contents


# REPORT OUTLINE

An executive summary of this report is presented in the Main Findings document.

This report is organised as follows:

**PART ONE – THE CASE FOR CHANGE**

1. **The Congestion Question:** outlines the project's background and its Terms of Reference.

2. **The Auckland Challenge:** discusses Auckland's key topographical features, and travel and trip patterns.

3. **Auckland Road Network Performance:** presents data outlining the current and forecast performance of the Auckland road network.

**PART TWO – CONGESTION PRICING THEORY AND PRACTICE**

4. **Congestion and Congestion Pricing:** describes congestion, discusses congestion costs, and provides an overview of the theoretical basis for levying congestion charges.

5. **International Review:** provides a survey of overseas experience with congestion pricing to derive the key lessons learned from successful and unsuccessful programmes.

6. **Congestion Pricing Policy:** provides a detailed examination of the main elements that make up a congestion pricing policy that determines the pricing structure that motorists could face.

7. **Community Considerations:** discusses congestion pricing from the perspective of the community.

8. **Technology Options:** discusses the technology options potentially available to implement a congestion pricing scheme in Auckland.

**PART THREE – OPTIONS FOR CONGESTION PRICING IN AUCKLAND**

9. **Options Development:** provides information on the longlist and shortlist options development process.

10. **Shortlist Options Evaluation:** presents the results of the evaluation exercise undertaken for the five shortlist options.

11. **Illustrative Tariff Concept:** develops an illustrative tariff concept for the two congestion pricing schemes identified as having the most potential for Auckland.

**PART FOUR – SOCIAL EVALUATION**

12. **Social Assessment:** presents the results of the refined social assessment to assess the financial effect of a potential congestion charge on Auckland and Māori households.

13. **Mana Whenua Assessment:** presents the results of an initial impact assessment on Mana Whenua in Tāmaki Makaurau.

14. **Vulnerable Households Assessment:** presents the results of the market research exercise undertaken to assess the impact of a potential congestion charge on vulnerable Auckland households.

15. **Mitigation Measures:** outlines a possible mitigations policy, to target road-users or households that may require compensation for the financial burden of any congestion charge.

**PART FIVE – SCHEME IMPLEMENTATION**

16. **Implementation Tasks:** outlines the main tasks that will underpin the introduction of a congestion pricing scheme in Auckland.

17. **Rollout Options:** presents three different rollout options for an Auckland congestion pricing scheme.

18. **Illustrative Timetable:** presents an illustrative implementation timetable based on the preferred rollout option and the adopted Auckland Regional Land Transport Plan (RLTP).

**PART SIX – CONCLUSIONS**

19. **Conclusion:** presents the conclusion of the technical investigation.

20. **Next Steps:** discusses next steps for the continuation of the project.

**DEFINITIONS AND ABBREVIATIONS**

A table of definitions and abbreviations used throughout this report.

**ANNEX: OPTIONS REFINEMENT**

Outlines the spatial changes that were made to the preferred schemes in the final stages of investigation, to improve their predicted performance against the project's evaluation criteria.

Part one

# THE CASE FOR CHANGE

**The Congestion Question (TCQ) project is a technical investigation by officials from six government agencies (the Ministry of Transport, Auckland Council (AC), Waka Kotahi NZ Transport Agency (Waka Kotahi), Auckland Transport (AT), The Treasury and the State Services Commission) to consider whether there is a case for introducing a congestion pricing scheme for Auckland.**

**PART ONE – THE CASE FOR CHANGE** outlines the context for the project and provides background on Auckland's roading network:

1. **The Congestion Question:** outlines the project's background and its Terms of Reference.
2. **The Auckland Challenge:** discusses Auckland's key topographical features, and travel and trip patterns.
3. **Auckland Road Network Performance:** presents data outlining the current and forecast performance of the Auckland roading network.

# 1 THE CONGESTION QUESTION

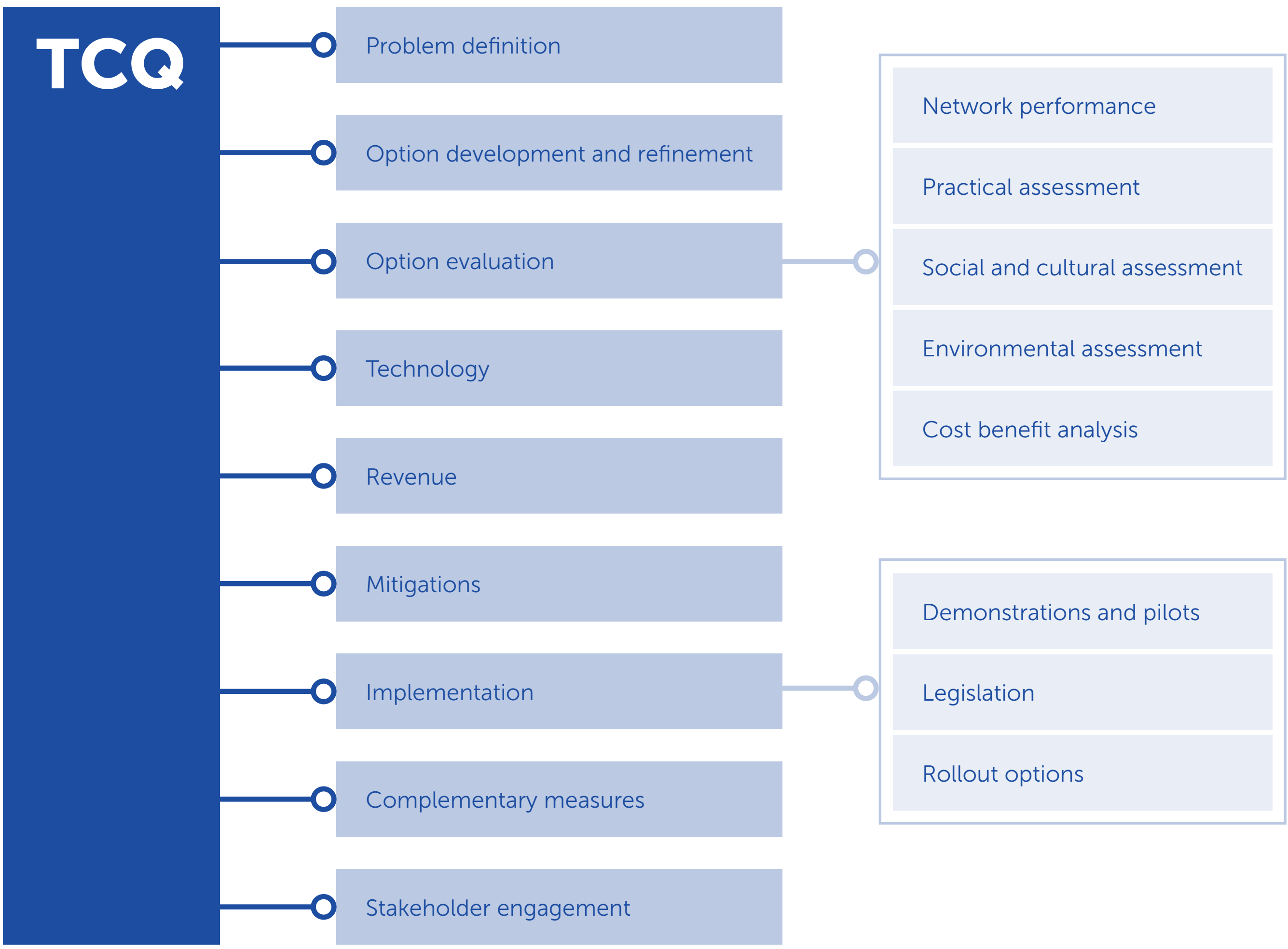
## 1.1 Project background

Central Government and Auckland Council officials have been working together for several years on a project called The Congestion Question (TCQ). The purpose of the project is to undertake a thorough investigation sufficient to support a decision on whether or not to proceed with introducing congestion pricing in Auckland.

Congestion pricing is a method used to improve the overall performance of the transport network ('network performance') by charging road users a fee to travel at different times and/or locations. The charge imposed encourages some users to change the time, route or way in which they travel (or not to travel at all). A change in some people's behaviour contributes to a reduction in congestion; even a relatively small reduction in traffic can have a big impact on improving congestion.

This report brings together TCQ's research, options development and evaluation, and technology, social and implementation considerations around a potential congestion pricing scheme for Auckland, as well as providing some insights into how such a scheme could be implemented. An executive summary of this report is presented in the Main Findings document. The TCQ work programme is summarised in Figure 1.

**FIGURE 1: WORK PROGRAMME SUMMARY**



## 1.2 Auckland Transport Alignment Project

The TCQ investigation builds on the findings of the Auckland Transport Alignment Project (ATAP), which set out a 30-year vision for Auckland's transport system. ATAP confirmed that the well-discussed adage, 'you can't build your way out of congestion', is also true in Auckland. While there are necessary capacity improvements and new projects required, ATAP identified that a greater focus is required on influencing travel demand through smarter transport pricing. This is in conjunction with implementing a substantial investment programme with an emphasis on public transport and generating more efficient use of our existing networks.

The ATAP report recommended the early establishment of a dedicated project to progress 'smarter' transport pricing with a primary focus on addressing congestion.

## 1.3 TCQ Terms of Reference

The Terms of Reference required TCQ to undertake design, testing and analysis of a shortlist of congestion pricing options to improve the performance of Auckland's road network by encouraging more efficient patterns of travel, taking into account economic, social and environmental outcomes. As part of achieving the objective, consideration must be given to the following matters:

- Appropriately balancing any additional costs of travelling against the benefits of improved network performance
- Ensuring pricing is flexible and adaptable to changing circumstances, such as developing technology or changing land-use patterns
- Ensuring key impacts of pricing (including fairness, equity and distributional impacts[1]) on those using the transport system, both businesses and households, are understood and appropriately addressed
- Assessing how any net revenue raised through pricing would be used
- Ensuring pricing is affordable and cost-effective to implement, operate, administer and enforce.

1 In this context, distributional impacts refer to how the impacts of transport projects or interventions vary across different groups within society.

# 2 THE AUCKLAND CHALLENGE

This section discusses the Auckland context for examining the potential case for introducing congestion pricing. Overseas precedents of successful congestion pricing schemes exist, but these need to be considered in the context of Auckland's unique environment. Schemes that have worked well elsewhere may not be as effective in improving congestion across Auckland.

The challenge for TCQ is to determine whether the lessons from the overseas congestion pricing schemes can be applied to the local environment. A potential congestion pricing scheme must consider Auckland's unique geography and address Auckland's specific transport challenges and needs, while avoiding unintended socio-economic impacts.

## 2.1 Population

Around 1.7 million people currently live in the Auckland region. Over the next 30 years the Auckland population is forecast to grow by an additional 730,000 people to reach 2.4 million. By 2050, most growth will be focussed in and around the city centre, the nodes of Albany, Westgate and Manukau, and be supported by development areas[2]. Incremental growth will also occur across existing urban areas as the intensification allowed for in the Auckland Unitary Plan is utilised.

Outside the core urban area, a number of areas have been designated as 'future urban'. Kumeu/Huapai, Whenuapai/Red Hills, Dairy Flat/Silverdale and Drury are all zoned 'future urban', along with the satellite towns of Warkworth and Pukekohe, which will act as rural nodes. These areas are intended under Auckland's Unitary Plan, the Auckland Plan and Future Urban Land Supply Strategy (FULSS), to support significant business and residential growth as well as servicing their surrounding rural communities. They will be connected to urban Auckland through state highways and, in the case of Pukekohe and Drury, by rail.

**TABLE 1: AUCKLAND POPULATION FORECAST**

| Auckland population forecast | | | |
|---|---|---|---|
| **Area / zone** | **Population 2018** | **Population growth (2018 – 2048)** | **Population (2048)** |
| Existing urban | 1,029,252 | 214,168 | 1,243,420 |
| Development areas | 447,407 | 228,446 | 675,853 |
| Future urban | 68,804 | 251,353 | 320,157 |
| Rural | 120,346 | 35,220 | 155,566 |
| **Total** | **1,665,809** | **729,188** | **2,394,997** |

*Source: StatsNZ, Auckland Forecasting Centre*

2 Development areas are specific locations that are expected to undergo a significant amount of housing and business growth in the next 30 years. In Auckland, there are approximately 18 development areas identified for targeted investment over the next 30 years with development prioritised in: Takapuna & Northcote; New Lynn & Avondale; Roskill South; Glen Innes, Tāmaki & Panmure; Ōtāhuhu; Onehunga and Māngere. https://www.aucklandcouncil.govt.nz/plans-projects-policies-reports-bylaws/our-plans-strategies/auckland-plan/development-strategy/growth-urban-auckland/Pages/growth-development-areas.aspx

## 2.2 Topography

Geography will continue to shape Auckland's development due to the location of its harbours, which have created an urban area, home to over 90% of the region's residents, defined by a narrow axis stretching from Orewa in the north to Drury in the south. Physical pinch points, particularly where the isthmus is at its narrowest, constrains and complicates the development of transport infrastructure and supporting services.

The form of the existing urban and suburban areas of Auckland has been heavily influenced by the transport modes of the time. The oldest and highest-density neighbourhoods, the central city and inner-city suburbs were developed along tram and railway lines. These continue to be accessible by public transport, walking and cycling. By contrast, the development of the motorway system resulted in the rapid growth of lower density suburbs, heavily reliant on private vehicles.

The Auckland region comprises four large intra-urban population and economic centres: the Isthmus, North Shore, Manukau/South and West Auckland, each with established local amenities encompassing employment, education, retail, health, and leisure facilities. An approximation of these broad areas is indicated in Figure 2

**FIGURE 2: AUCKLAND CONTEXT**

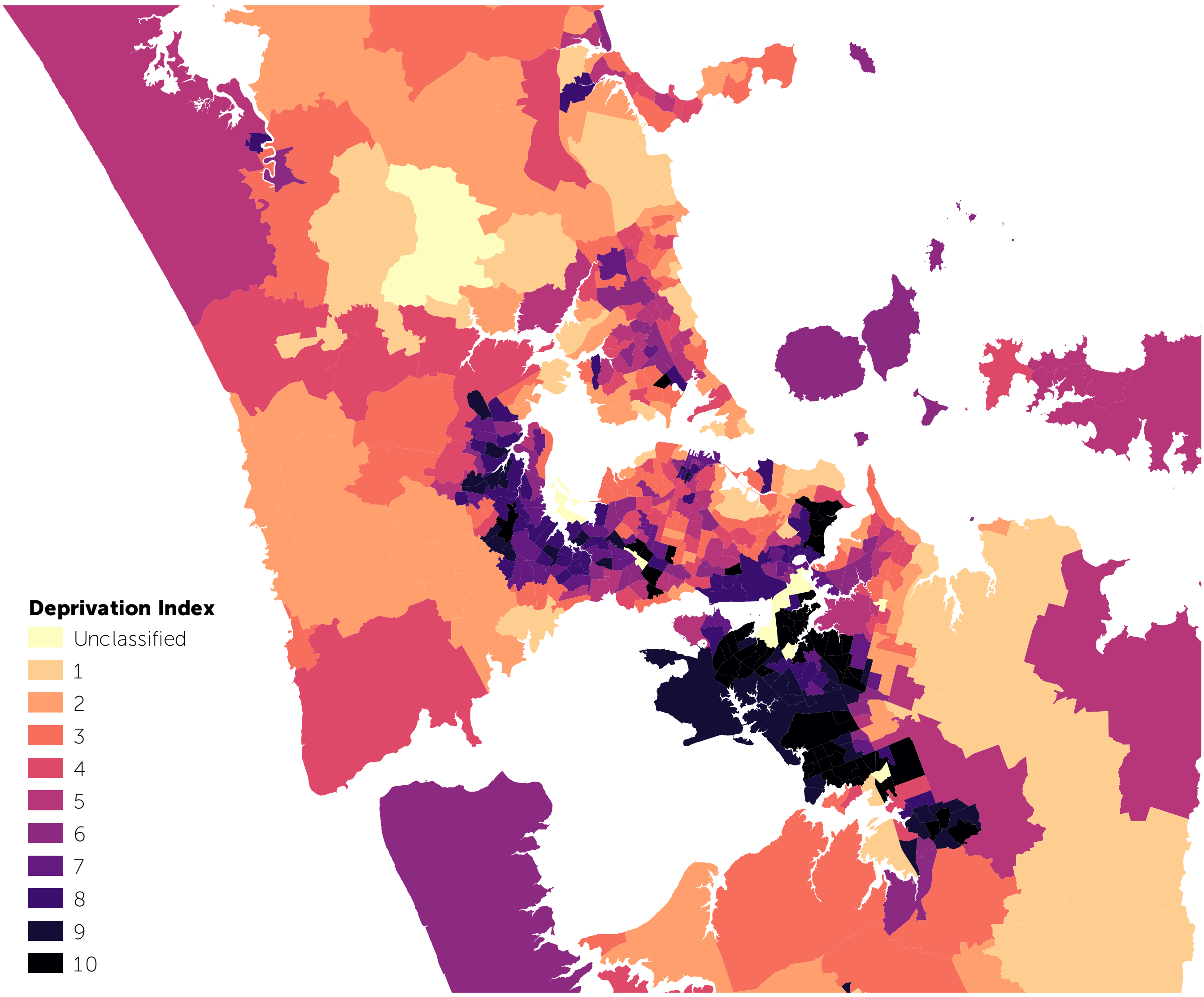
From the perspective of congestion pricing, the presence of harbours and other topographical features will help to provide some natural features and boundaries that will influence the design of any scheme.

## 2.3 Household incomes

An understanding of Auckland's pattern of income distribution is an important input into the design of a potential congestion pricing scheme, so that financial impacts on vulnerable users can be mitigated where possible through the scheme design. Figure 3 shows the pattern of household deprivation (with colour coding to reflect relative deprivation scores, from low deprivation (score of 1) to high deprivation (score of 10)):

- Predominately low-income areas are situated in the west, south and along the southern corridor.
- Higher income suburbs are found in the isthmus, North Shore and east Auckland.
- Areas with economic deprivation are often correlated with higher car dependency.
- Higher income areas are often correlated with better access to public transport services.

**FIGURE 3: HOUSEHOLD DEPRIVATION (2018)**




*Source: https://www.otago.ac.nz/wellington/departments/publichealth/research/hirp/otago020194.html*

## 2.4 Car ownership

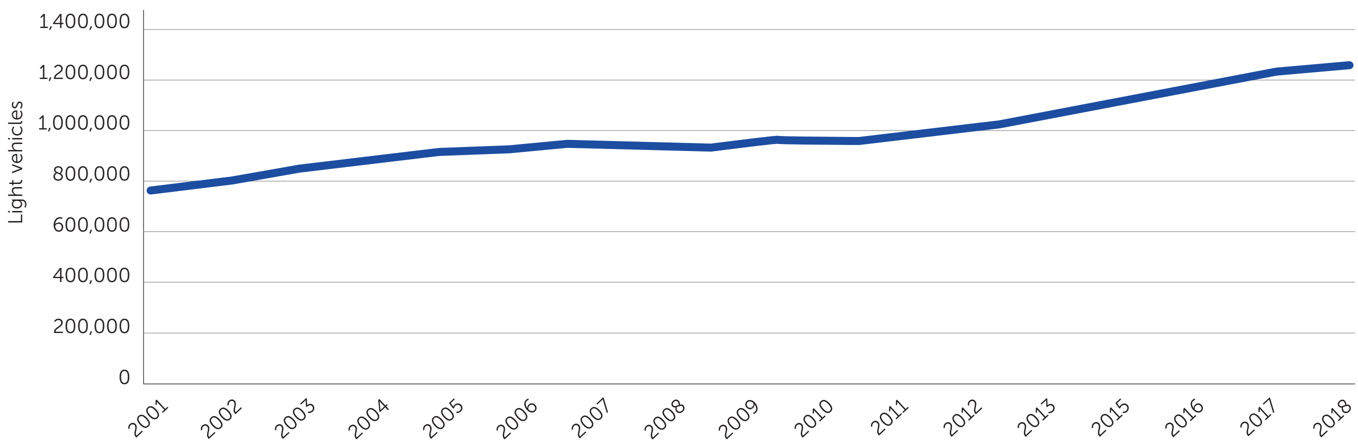
There are approximately 1.3 million light vehicles[3] in the greater Auckland region, used by approximately 1.7 million people. Although Auckland is known for its love of cars, it actually has fewer vehicles per capita than most of New Zealand, with 744 light vehicles per 1,000 people, compared with the national average of 802 per 1,000.

These vehicles are owned by approximately 560,000 households and more than half of all households (58% in the 2013 census) have access to two or more vehicles.

Only 8% of households have no vehicle, (a large number of these are in the inner city), while 34% have one vehicle.

Figure 4 shows the number of light vehicles in the region based on where they received a Warrant or Certificate of Fitness[4] (WoF/CoF). It reveals that ownership has steadily increased, especially since 2012, when the effects of the global financial crisis wore off.

**FIGURE 4: AUCKLAND LIGHT VEHICLE OWNERSHIP**



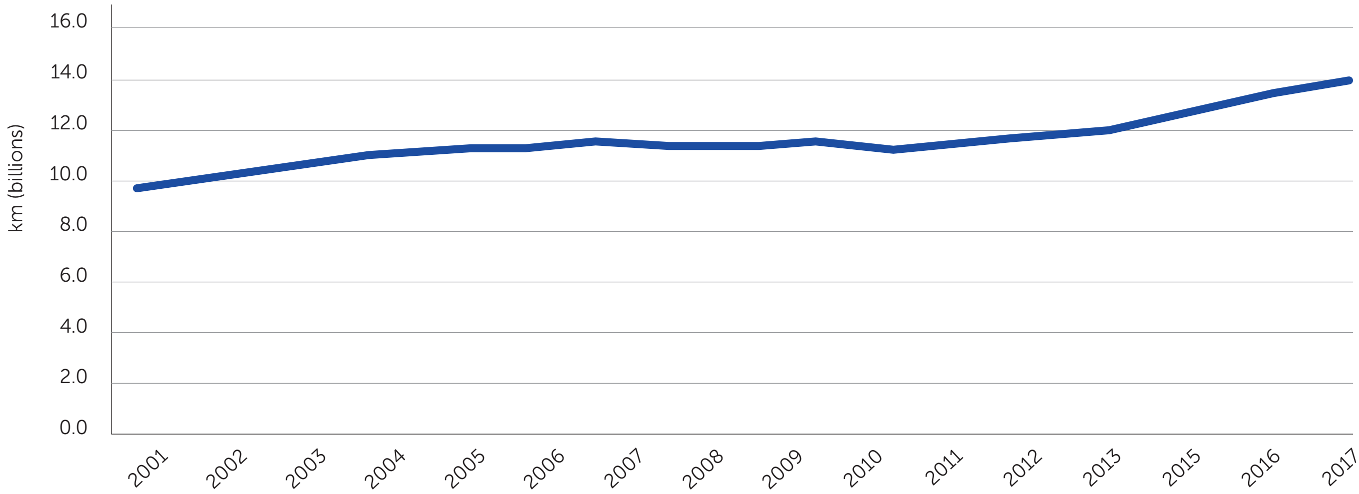

*Source: MoT Transport Dashboard*

3 Light vehicles include cars, vans, SUVs and 4WDs.
4 Inspection location is considered a better measure of ownership than registrations. This is because registration data will identify vehicles owned by companies with headquarters in Auckland but which are actually used outside Auckland. We use WoF records to confirm location of vehicles as used below in Section 2.5.1.

### 2.4.1 Auckland vehicle kilometres

Auckland's total vehicle travel recorded by all vehicles undergoing WoF/CoF inspection in Auckland, is also showing a steady upward trend as shown in Figure 5, which corresponds with the increase in vehicle ownership shown above in Figure 4.

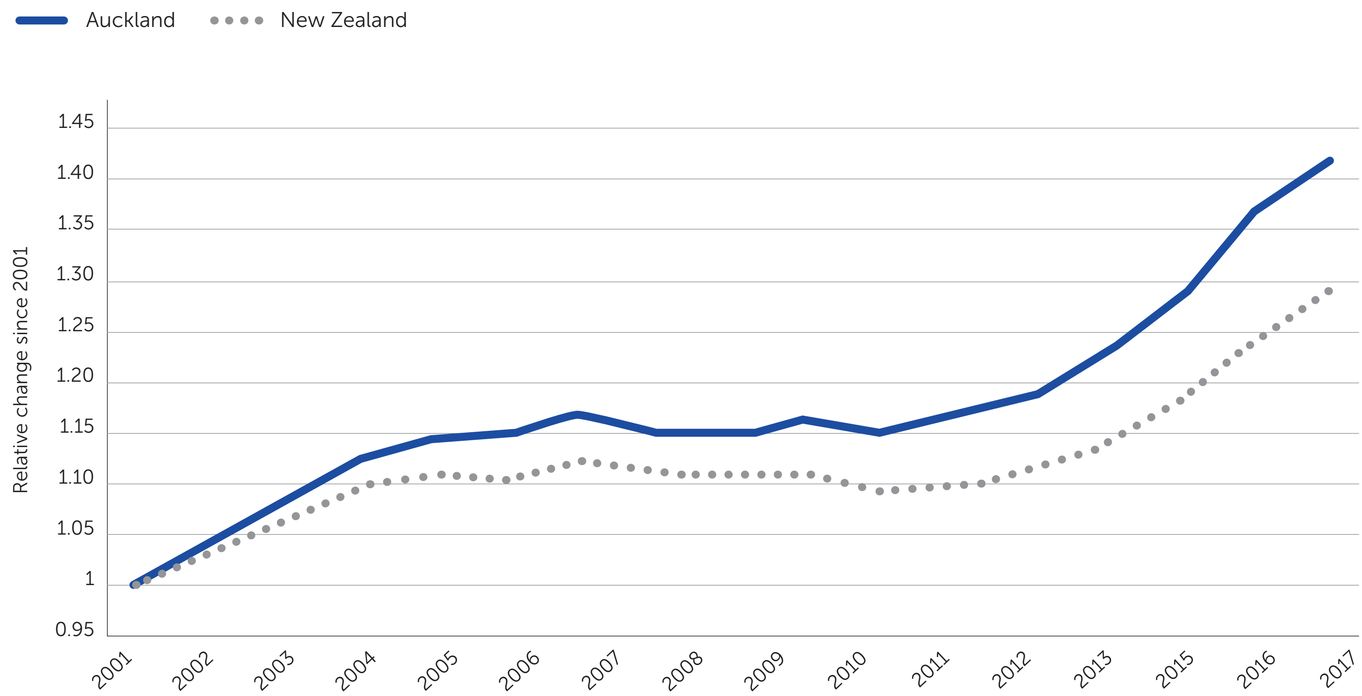
**FIGURE 5: GROWTH IN ANNUAL VEHICLE KILOMETRES TRAVELLED IN AUCKLAND**




*Source: MoT Transport Dashboard*

The total amount of travel by vehicles (referred to as vehicle kilometres travelled (VKT)) in Auckland has grown by 42% since 2001, compared with 29% across New Zealand, as shown in Figure 6.

## FIGURE 6: INCREASE IN TRAVEL - AUCKLAND COMPARED TO NZ




*Source: MoT Transport Dashboard*

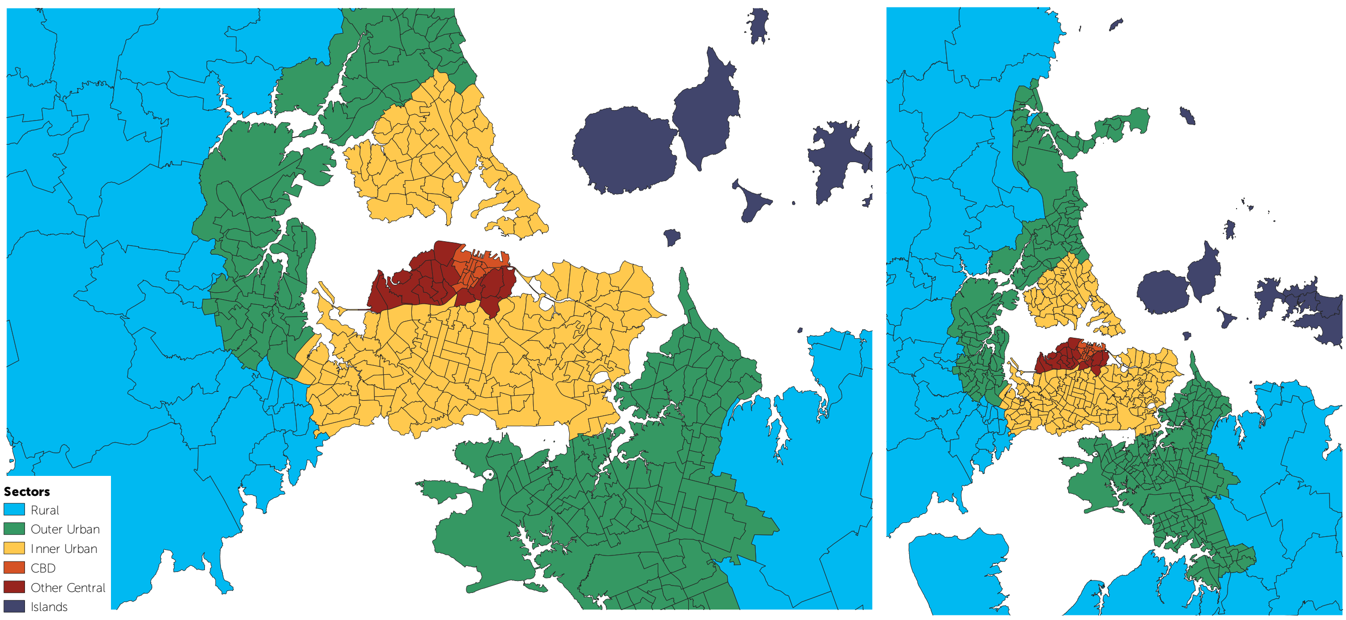
This 42% increase in VKT compares with a 36% rise in population, suggesting a slight increase in VKT per person. When compared to the 60% increase in vehicle ownership (refer to Figure 4), this suggests that VKT per vehicle has actually declined. This is consistent with the national pattern of declining travel per vehicle as the number of vehicles increases.

## 2.5 Travel patterns

Travel patterns reflect Auckland's urban form and dispersed employment arrangements. Census data from 2013 and 2018 has been analysed to provide insights into commuting patterns for Auckland, which represent the largest component of travel during congested periods. Some analysis discussed in this section provides a sectorised view of Auckland, using the sectors outlined in Figure 7. These sectors are consistent between the two years' analysis.

The results and analysis of the journey to work data from the 2018 census presented in this section are preliminary. In considering this analysis it should be noted that there are a number of differences between the censuses for 2013 and 2018 and the ways in which they have been analysed, which limits the ability to make reliable comparisons over time. The data sought by the census in 2018 was for a normal journey to work whereas in 2013 it was for the journey to work on a specific day that resulted in a number of people not recording any trip details. In addition, the information provided by Statistics NZ for 2018 had a higher level of data suppression to protect confidentiality, particularly at the sectorised level. For this reason, absolute comparisons of 2018 with 2013 should be viewed with caution, particularly at a detailed level. In some instances, specific adjustments have been made to allow an improved level of comparison between years. In general, the evidence suggests that the total number of journey to work trips within the Auckland region has increased by about 14 per cent between 2013 and 2018. However, because of the way in which the data has been analysed, the differences between the totals presented for specific analyses for 2013 and 2018 are often larger.

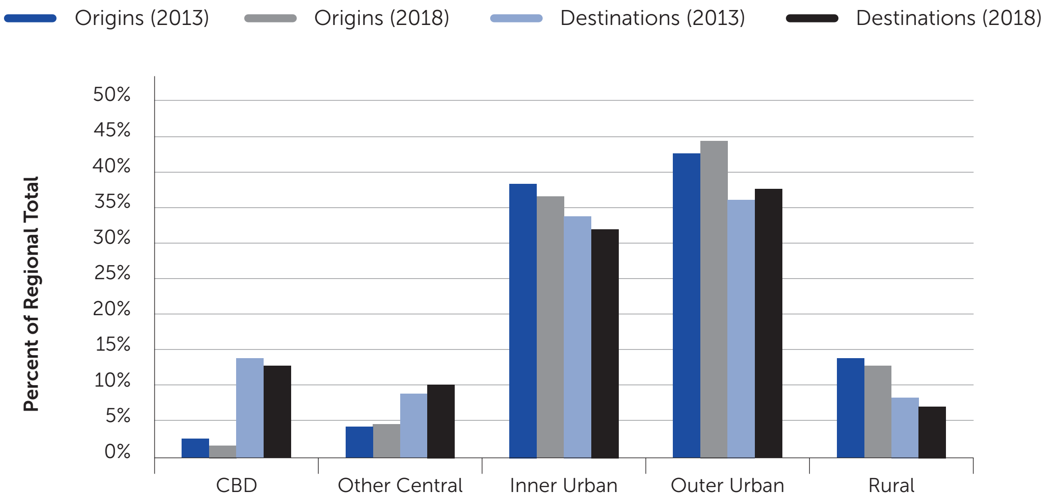
**FIGURE 7: JOURNEY TO WORK ANALYSIS SECTORS**




*Source: Source: Journey to Work Patterns (2013 census), Richard Paling Consulting (2014)*

Figure 8 provides a graphical comparison of the sectorised commuting patterns for the two census years, showing proportion of trips by origin and destination sectors of Auckland.

**FIGURE 8: ORIGINS AND DESTINATIONS FOR COMMUTER TRIPS BY SECTOR**




*Source: Journey to Work Patterns (2013 census), Richard Paling Consulting (2014), Journey to Work Patterns (2018 census) – preliminary analysis, Richard Paling Consulting (2020)*

The comparison in Figure 8 highlights the broad consistency in travel patterns between the two years. There has been a slight increase in the share of trips to central area destinations (CBD and other central – corresponding to the city centre and fringe) and a shift of origin and destination share from the inner urban to outer urban sector.

Some relevant observations from the 2018 data, in the context of TCQ, include:

- The central areas (CBD and other central) only account for approximately 23% of employment related destinations.
- The inner urban sector accounted for 32% of employment related destinations, the outer urban sector for 38% and the rural sector for 7%.
- Auckland employment-related travel patterns are largely local and not dominated by significant inflows towards the city centre, confirming the dispersed nature of employment in Auckland.
- A more granular analysis confirms that away from the centre, employment areas generally attract workers from surrounding local areas, whereby some 35% of workers have jobs in the Local Board area in which they live.
- The extent of commuting against the general pattern of peak direction flows is relatively low.
- Commuting patterns suggest workers are attracted to regional employment centres to take advantage of lower priced housing and seek to avoid longer commutes to central areas of Auckland.

## 2.6 Travel modes

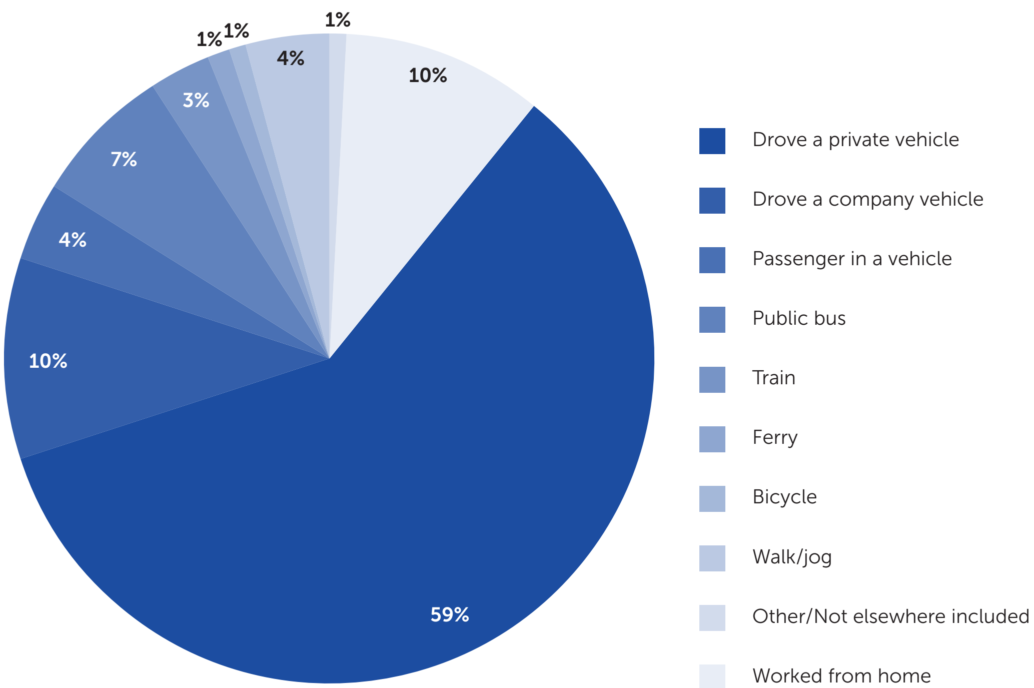
### 2.6.1 Commuter mode share

Figure 9 shows the commuting mode shares from the 2018 journey to work analysis. While there have not been any fundamental changes since 2013, there have been small increases in public transport mode share and the proportion of people working from home. Figure 9 highlights that private vehicle travel is clearly the dominant mode, accounting for nearly 75% of commuting travel across the Auckland region.

Analysis of the journey to work mode share is also available at the sectorised destination level as shown in Table 2 for 2013 and 2018. The trends across the region broadly remain the same in both years, with the share of private vehicle trips increasing with distance away from the city centre, as visualised in Figure 10. From the summary provided in Table 2, we see:

- Mode share of private vehicle by destination for all commuting trips has reduced slightly from 75% in 2013 to 72% in 2018 but remains at a similar level (81%) once working from home is excluded.
- Private vehicle use increases with distance away from the central area with the mode share for private vehicles staying at over 80% for the outer urban area.
- The mode share for public transport:
    - o to the city centre has increased substantially from approximately 27% in 2013 to 41% in 2018. Auckland Transport's more detailed city centre mode share surveys reinforce this trend, with public transport carrying 45% of trips into the city centre in 2020.

**FIGURE 9: AUCKLAND JOURNEY TO WORK MODES (2018)**




*Source: Journey to Work Patterns (2018 census) – preliminary analysis, Richard Paling Consulting (2020)*

- o to the central area (excluding the city centre) has increased from approximately 12% in 2013 to 22% in 2018.
  - o falls with increasing distance from the central area.
- Active mode share continues to decrease with distance away from the city centre, noting that 2018 active mode trips at a sector level, particularly to the city centre, are likely to be underreported due to data issues referred to earlier.

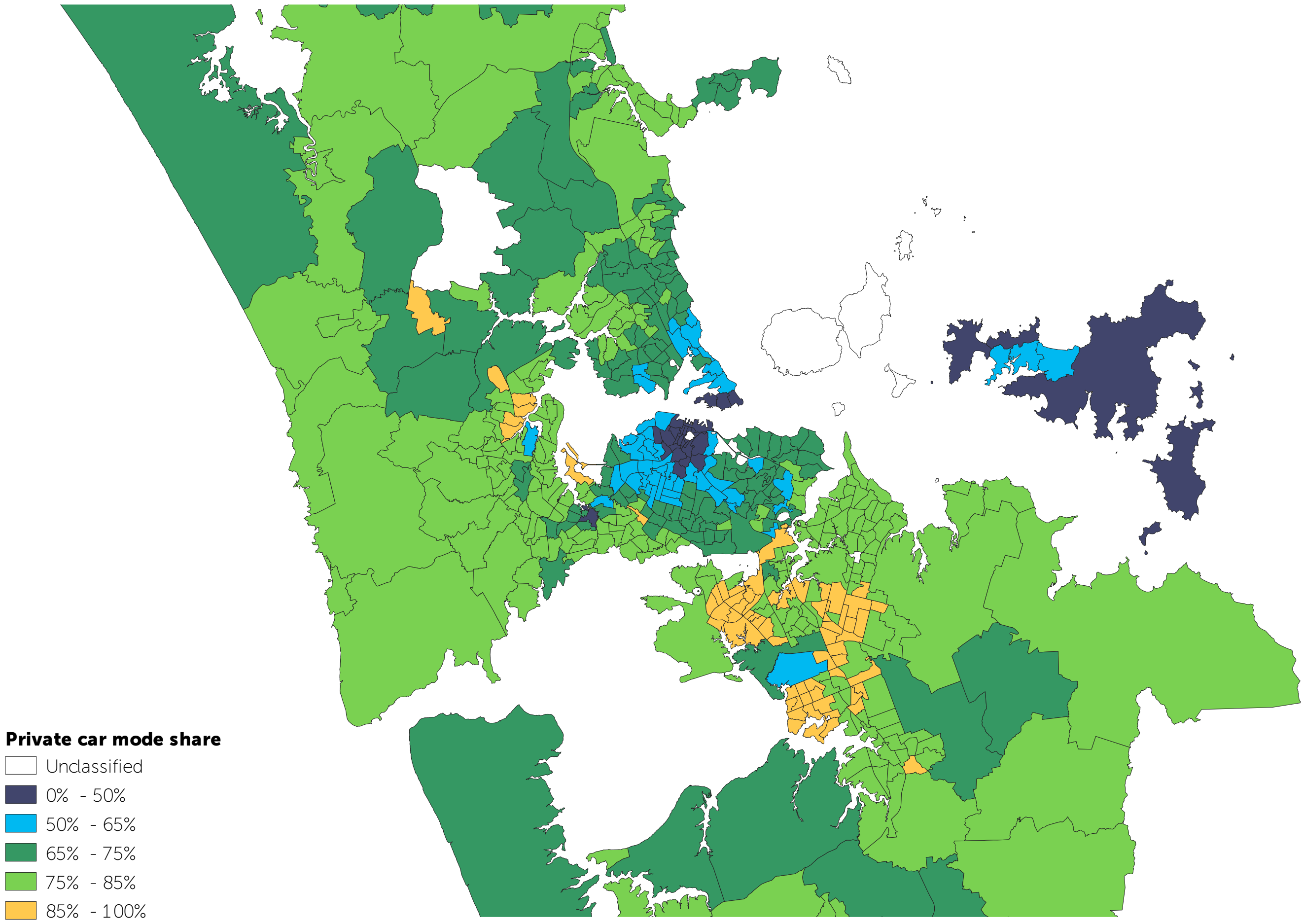
**TABLE 2: MODES USED BY WORKPLACE/DESTINATION SECTOR[5]**

| Sector | CBD | Other Central | Inner Urban | Other Urban | Rural | Total |
|---|---|---|---|---|---|---|
| **SUMMARY BY DESTINATION: PERCENT OF TOTAL (2013)** | | | | | | |
| Car users | 55% | 71% | 78% | 83% | 67% | 75% |
| Bus | 21% | 9% | 4% | 2% | 2% | 6% |
| Train | 6% | 3% | 1% | 1% | 0% | 2% |
| Ferry | - | - | - | - | - | - |
| Walked or jogged | 10% | 7% | 4% | 3% | 4% | 5% |
| Bicycle | 2% | 2% | 1% | 1% | 1% | 1% |
| Other | 5% | 3% | 3% | 3% | 3% | 3% |
| Worked at home | 2% | 6% | 9% | 8% | 23% | 8% |
| **Total** | **100%** | **100%** | **100%** | **100%** | **100%** | **100%** |
| **SUMMARY BY DESTINATION: PERCENT OF TOTAL (2018)** | | | | | | |
| Car users | 44% | 62% | 76% | 81% | 64% | 72% |
| Bus | 28% | 13% | 5% | 3% | 1% | 7% |
| Train | 9% | 7% | 2% | 1% | 0% | 3% |
| Ferry | 4% | 2% | 0% | 0% | 0% | 1% |
| Walked or jogged | 13% | 5% | 3% | 2% | 3% | 4% |
| Bicycle | 1% | 3% | 1% | 0% | 0% | 1% |
| Other | 0% | 3% | 1% | 1% | 0% | 1% |
| Worked at home | 2% | 4% | 11% | 11% | 31% | 11% |
| **Total** | **100%** | **100%** | **100%** | **100%** | **100%** | **100%** |

*Source: Journey to Work Patterns (2013 census), Richard Paling Consulting (2014), Journey to Work Patterns (2018 census) – preliminary analysis, Richard Paling Consulting (2020)*

5 Note that in 2013, ferry trips were included in 'other', with the line included in the table to allow an easier comparison to 2018.

#### FIGURE 10: PRIVATE CAR MODE SHARE BY RESIDENTS, PERCENT OF TOTAL TRIPS (2018)




*Source: Journey to Work Patterns (2018 census) – preliminary analysis, Richard Paling Consulting (2020)*

## 2.7 Trip lengths

Trip lengths are an important consideration in the context of developing an effective congestion pricing scheme. To contribute to a meaningful improvement in network performance, a significant number of trips, irrespective of distance, need to be provided with the incentive to consider changing their travel behaviour if their default is to drive.

Travel distances by mode are highest for rail travel and lowest for cycling and walking commuters, with the average commute distance being approximately 12km as shown in Table 3 for 2013. Average trip length by mode in 2018 shows a slight increase (less than 5%) over the 2013 trip lengths for most modes when adjustments are made to better compare like with like.

Table 4 shows the trip length by sector, for place of residence and for place of work for 2013. Sectorised trip length data is not yet available for the 2018 census. However, maps of average trip length by origin and destination zone (as opposed to sector) using the 2018 data are shown in Figure 11 and Figure 12 respectively, noting these should be regarded as illustrative.

This data shows that commuting distances from place of residence increase with distance away from the city centre area, highlighted by the incidence of pink and red shading

### TABLE 3: AVERAGE TRIP LENGTH BY MAIN MODE (2013)

| Mode | Average Trip Length (kms) |
|---|---|
| Private vehicle | 13.5 |
| Bus | 11.4 |
| Train | 15.9 |
| PT | 12.4 |
| Active | 6.7 |
| **Average all modes** | **11.8** |

*Source: 2013 census or Journey to Work Patterns, Richard Paling Consulting (2014)*

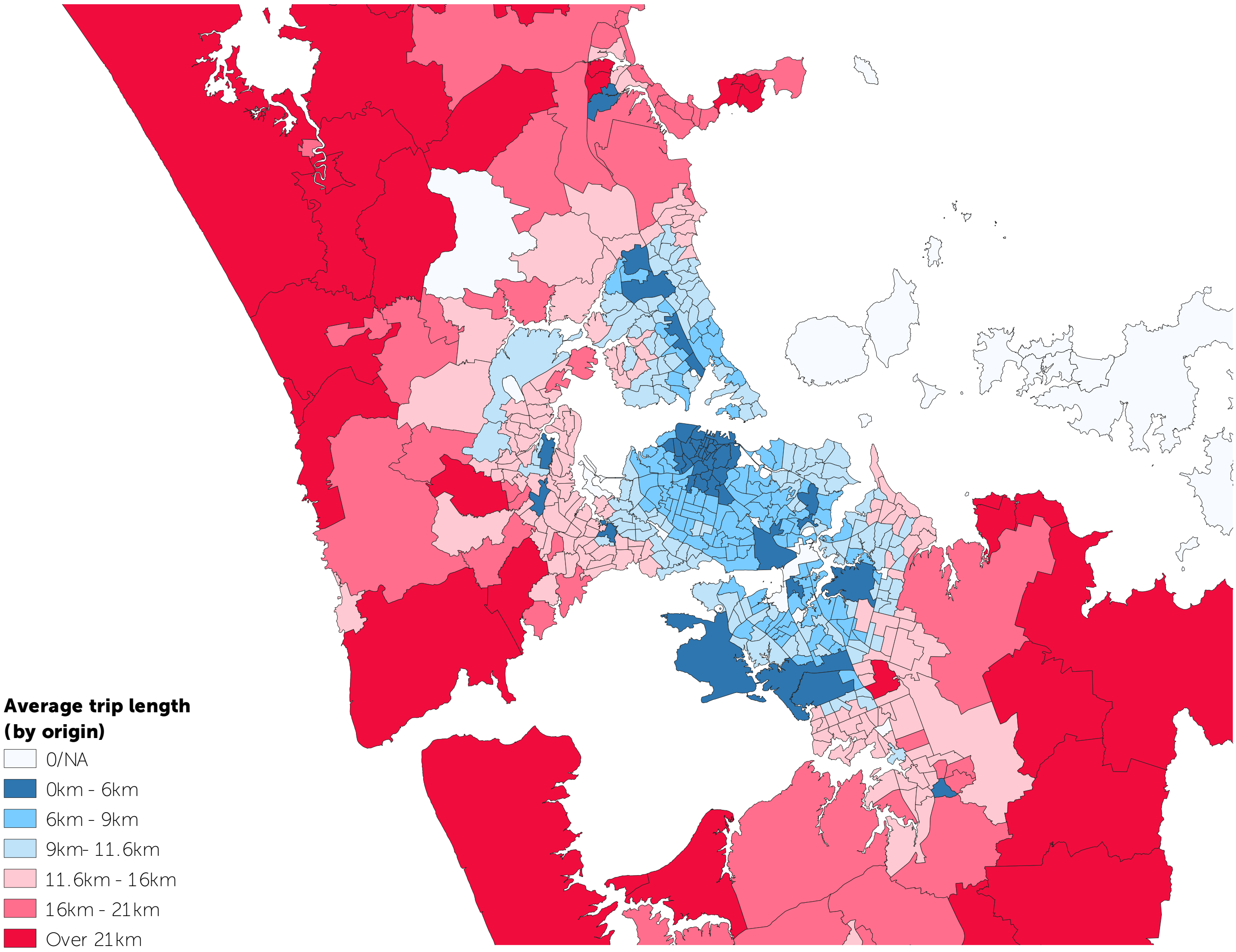
### TABLE 4: TRIP LENGTH BY SECTOR (2013)

| | By Place of Work | | By Place of Residence | |
|---|---|---|---|---|
| Sector | Average Distance (kms) | Percent of Average | Average Distance (kms) | Percent of Average |
| CBD | 12.1 | 103% | 5.1 | 43% |
| Other | 11.2 | 95% | 6.1 | 52% |
| Inner Urban | 10.8 | 92% | 9.2 | 78% |
| Outer Urban | 12.4 | 105% | 13.1 | 111% |
| Rural | 13.4 | 114% | 18.9 | 160% |
| **Total** | **11.8** | **100%** | **11.8** | **100%** |

*Source: 2013 census or Journey to Work Patterns, Richard Paling Consulting (2014)* (representing distances greater than 12km) in zones further from the city centre in Figure 11. People living in the central area are commuting for 6km or less on average, while those who live in the outer urban area are travelling more than twice this distance on average.

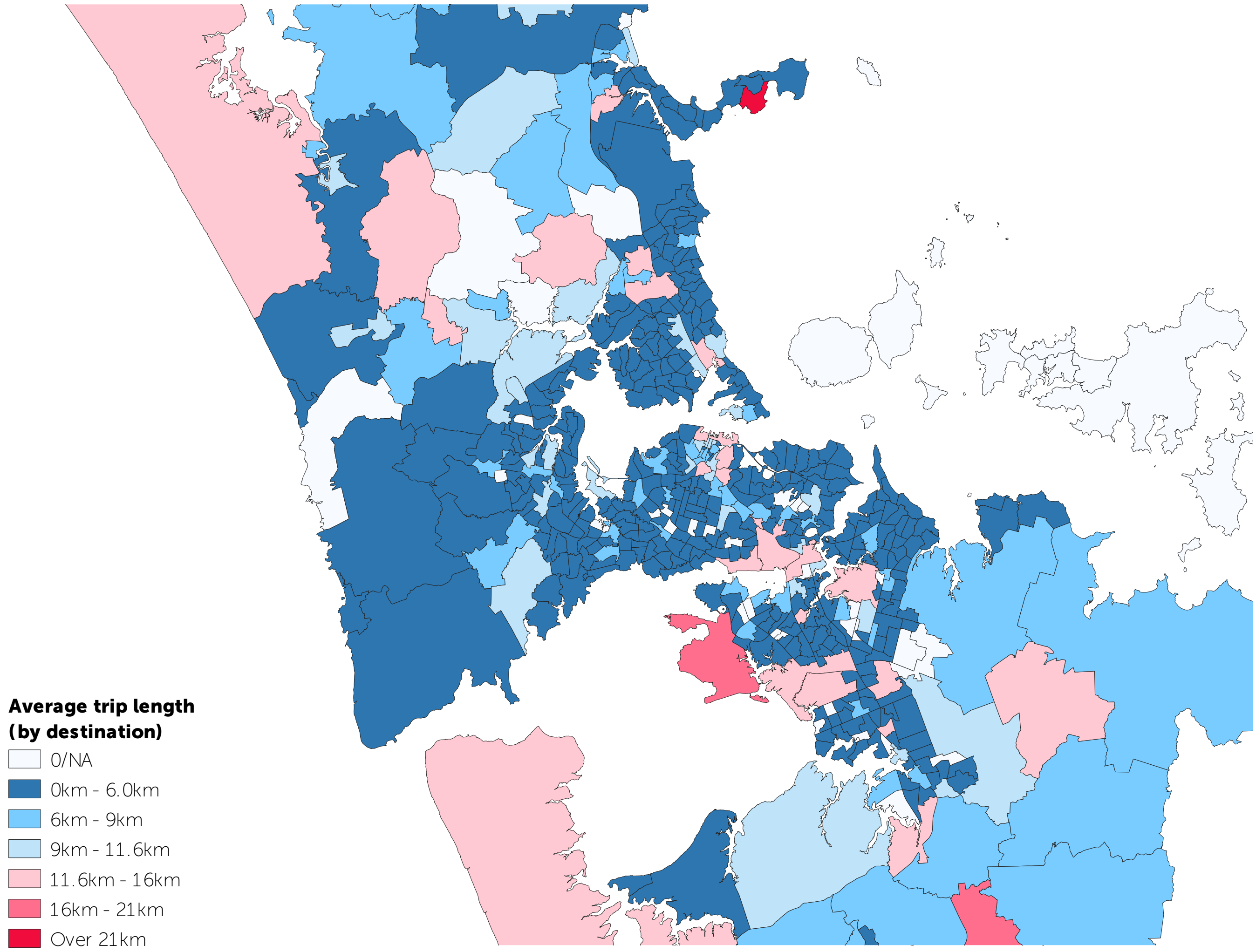
The average distance that employees travel to their place of work does not vary greatly across destinations, demonstrating that employment centres are geographically spread across Auckland. This is highlighted by the majority of zones being shaded blue (representing distances less than 12km) in Figure 12.

### FIGURE 11: AVERAGE TRIP LENGTH BY ORIGIN (2018)




*Source: Journey to Work Patterns (2018 census) – preliminary analysis, Richard Paling Consulting (2020)*

## FIGURE 12: AVERAGE TRIP LENGTH BY DESTINATION (2018)




*Source: Journey to Work Patterns (2018 census) – preliminary analysis, Richard Paling Consulting (2020)*

# 3 AUCKLAND ROAD NETWORK PERFORMANCE

This section provides information on the current performance of Auckland's road network. In addition, updated forecasts are presented on how Auckland's transport system is likely to evolve over the next 30 years without the introduction of congestion pricing (ie as a base case). The analysis shows that Auckland's congestion[6] has worsened over the past few years, and although future investment is expected to make a critical contribution, without some other change, such as a form of congestion pricing, overall network performance will deteriorate further. The result is that Aucklanders' access to jobs, education and other opportunities will become more difficult and travel times more variable. Research is also presented that attempts to put a value on the cost that traffic congestion in Auckland imposes on the local economy.

## 3.1 Current performance of Auckland's road network

### 3.1.1 Levels of service

A level of service (LoS) is often used to report on the performance of a road network. There are several measures that can be used to define levels of service, such as vehicle speed, vehicle density, delay or volume to capacity (VC) ratio. Table 5 summarises LoS definitions for general road network performance, using the relationship between measured traffic flow and maximum flow (the volume to capacity or VC ratio) as the measure. Similar tables use traffic speed, density or delay as the measure for LoS.

6 'Traffic congestion' is defined as a condition on road networks that occurs as use increases, and is characterised by slower speeds, longer trip times and increased vehicular queuing. When traffic demand is large enough for the interaction between vehicles to slow the speed of the traffic, congestion begins to occur. As demand approaches the capacity of a road (or of the intersections along the road), congestion increases. Section 4 discusses the definition of congestion in more detail.

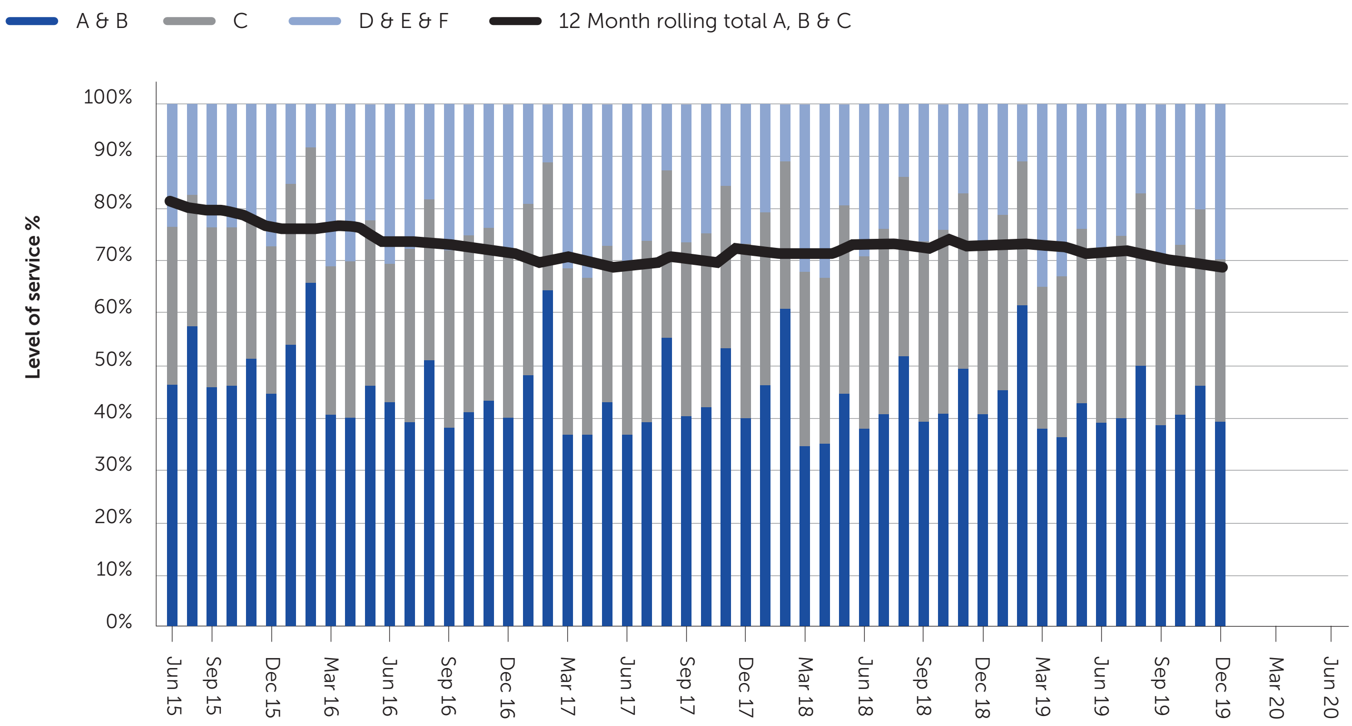
**TABLE 5: ROAD NETWORK PERFORMANCE LEVELS OF SERVICE**

| LoS | Description | Motorway /expressway VC ratio | Local/arterial road VC ratio |
|---|---|---|---|
| A | Free-flow conditions with unimpeded manoeuvrability. Stopped delay at signalised intersections is minimal. | <0.30 | <0.26 |
| B | Reasonably unimpeded operations with slightly restricted manoeuvrability. Stopped delays are not bothersome. | 0.30 < 0.48 | 0.26 < 0.43 |
| C | Stable operations with somewhat more restrictions in making mid-block lane changes than LoS B. Motorists will experience appreciable tension while driving. | 0.48 < 0.70 | 0.43 < 0.62 |
| D | Approaching unstable operations, where small increases in volume produce substantial increases in delay and decreases in speed. | 0.70 < 0.90 | 0.62 < 0.82 |
| E | Operations with significant intersection approach delays and low average speeds. | 0.90 < 1 | 0.82 < 1 |
| F | Extremely low speeds caused by intersection congestion, high delay and adverse signal progression. | ≥1 | ≥1 |

*Source: Transportation Research Board. Highway capacity manual (TRB 1994)*

Figure 13 shows the LoS on the Auckland arterial road network for the morning peak period. In November 2019, 71% of the network operated at good levels of service (LoS A–C), but this is 9% worse than the previous month and 2% lower than November 2018. On a rolling 12-month basis the performance of the Auckland network has resumed its decline following the improvement associated with the Waterview Tunnel opening in July 2017. For reference, 'severe congestion' generally refers to LoS E and F on the arterial network.

**FIGURE 13: LEVELS OF SERVICE FOR THE AUCKLAND ARTERIAL NETWORK FOR THE MORNING PEAK**



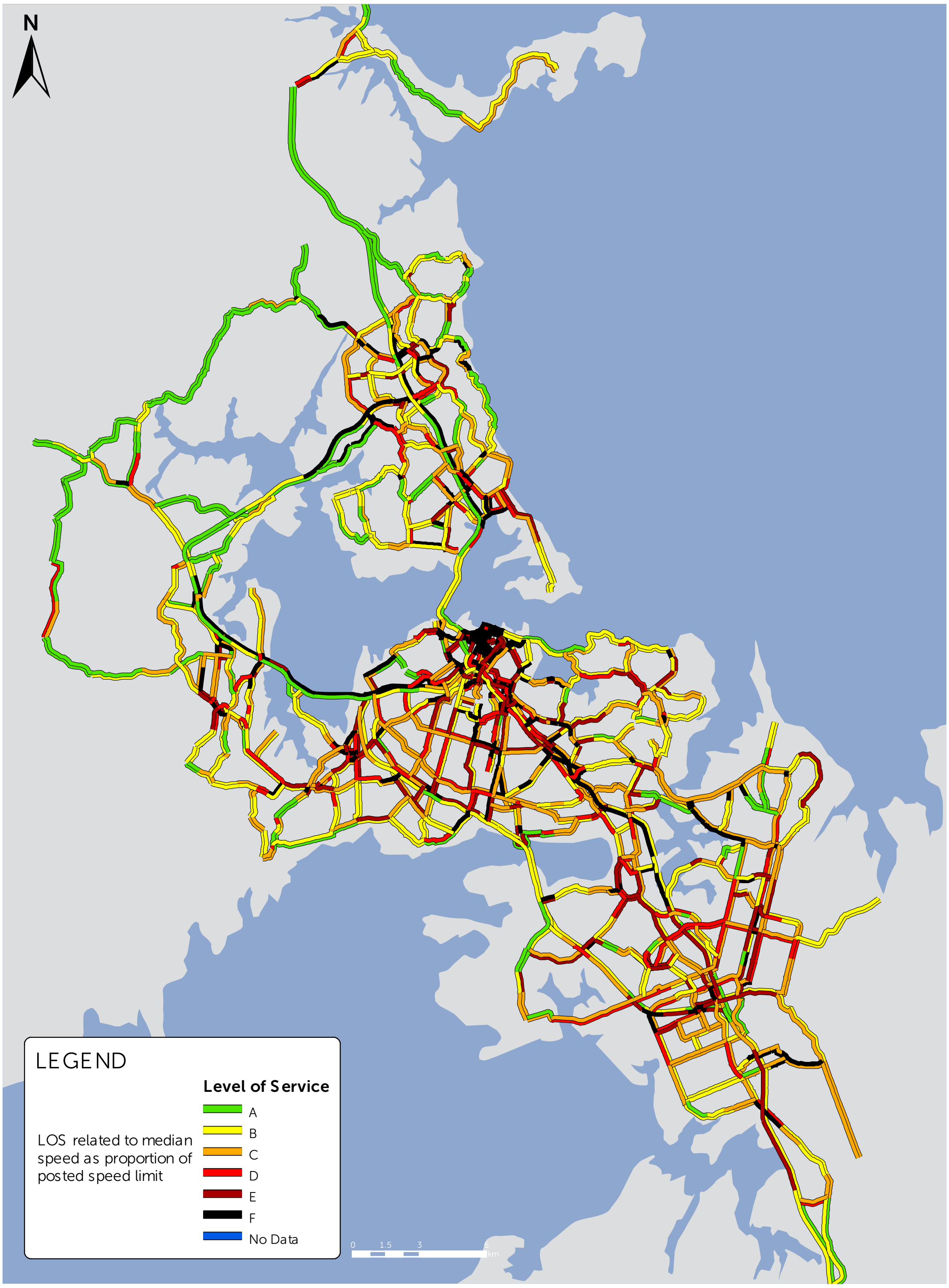

*Source: Auckland Transport*

## 3.1.2 Congestion maps

Figure 14 shows a map of the typical LoS across the arterial and motorway networks during the morning peak hour (07:30 – 08:30) for February 2020. Figure 15 shows the typical level of service across the arterial and motorway networks during the afternoon peak hour (16:30 – 17:30) for February 2020.

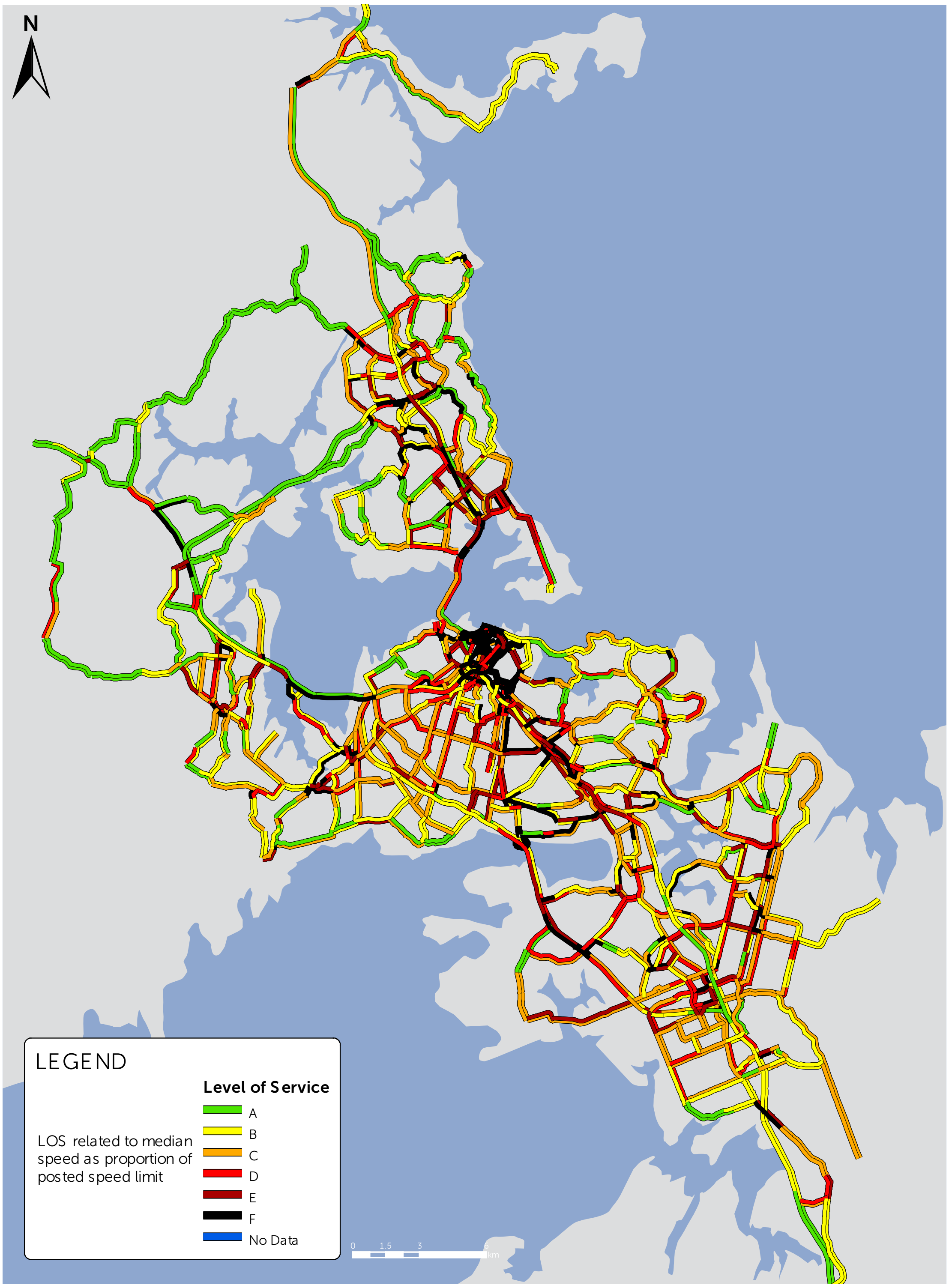
The maps demonstrate that large sections of the strategic roading network are experiencing congested conditions during the morning and afternoon peak periods, with severe congestion (dark red and black) more widespread in the morning peak. For reference, the measure used to calculate LoS in the maps in Figure 14 and Figure 15 is median speed as a proportion of posted speed limit.

### FIGURE 14: MORNING PEAK HOUR LOS ON ARTERIAL AND MOTORWAY NETWORK (FEBRUARY 2020)




*Source: Auckland Transport*

## FIGURE 15: AFTERNOON PEAK HOUR LOS ON ARTERIAL AND MOTORWAY NETWORK (FEBRUARY 2020)




*Source: Auckland Transport*

## 3.2 Future performance of Auckland road network

To generate a base case estimate of the future performance of the Auckland roading network, TCQ modelled the future network performance in the absence of congestion pricing (or other intervention) using the Auckland Forecasting Centre's (AFC) Macro Strategic Model (MSM). The modelling is based on:

- the most recent population and employment projections generated by Auckland Council[7]
- the assumption that the indicative package of transport investments recommended in the ATAP update report is implemented[8].

Under this base case scenario, continued rapid population growth is projected to lead to increases in demand for travel, with total daily trips by all modes rising from 5.4 million in 2016 to 7.8 million by 2046, an increase of 44%. Public transport and active mode share (walking and cycling) is forecast to increase significantly over this period, but the distance travelled by private vehicles is still expected to grow by 50% – increasing the pressure on the road network.

### 3.2.1 Forecast network performance

The modelling shows that without further actions in addition to those set out in the ATAP update, we expect congestion to continue to get worse.

While the major investment programme proposed in the ATAP update report provides significant new public transport and greenfield roading capacity in response to this growth, the scale of increased demand means that further declines in road network performance are still projected. The main effect predicted by the modelling is that congestion becomes more widespread on the existing road network, with the length of lane kilometres subject to severe congestion increasing by 40% over the next 30 years.

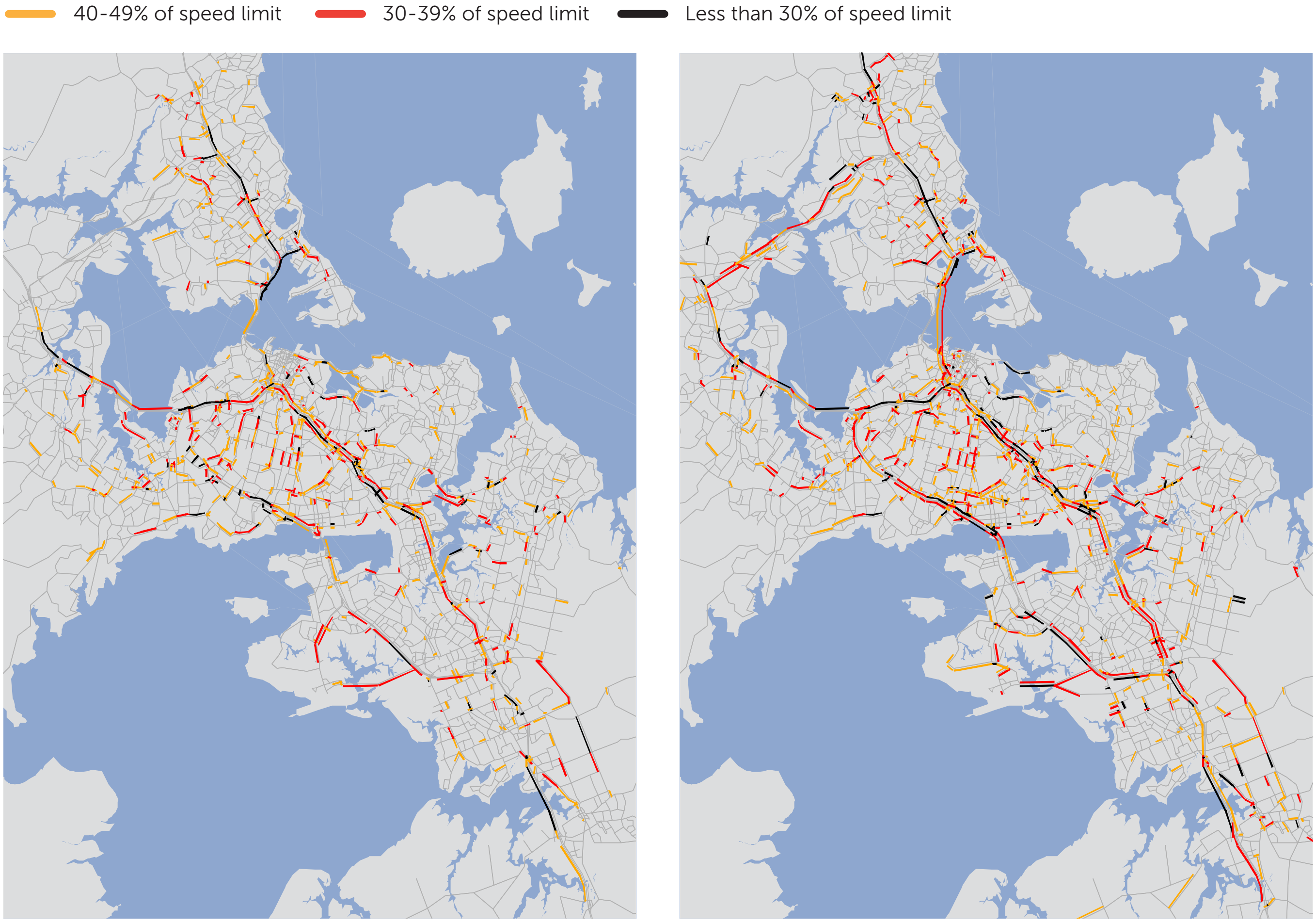
The forecast deterioration in network performance can be seen in Figure 16, which provides a comparison of severe congestion during the morning peak in 2016 and 2048. The motorway system is heavily affected, with the number of lane kilometres subject to severe congestion more than doubling and congestion spreading from the Bombay Hills in the south to Redvale in the north.

The modelling indicates that by 2048:

- the proportion of car travel in severe congestion increases by 29% in the morning and afternoon peaks and by 38% in the interpeak
- severe congestion on the freight network during both the morning peak and interpeak increases by 50%.

7 Scenario I11 based on Statistics New Zealand's sub-national population projections issued February 2017
8 Auckland Transport Alignment Project report (2018)

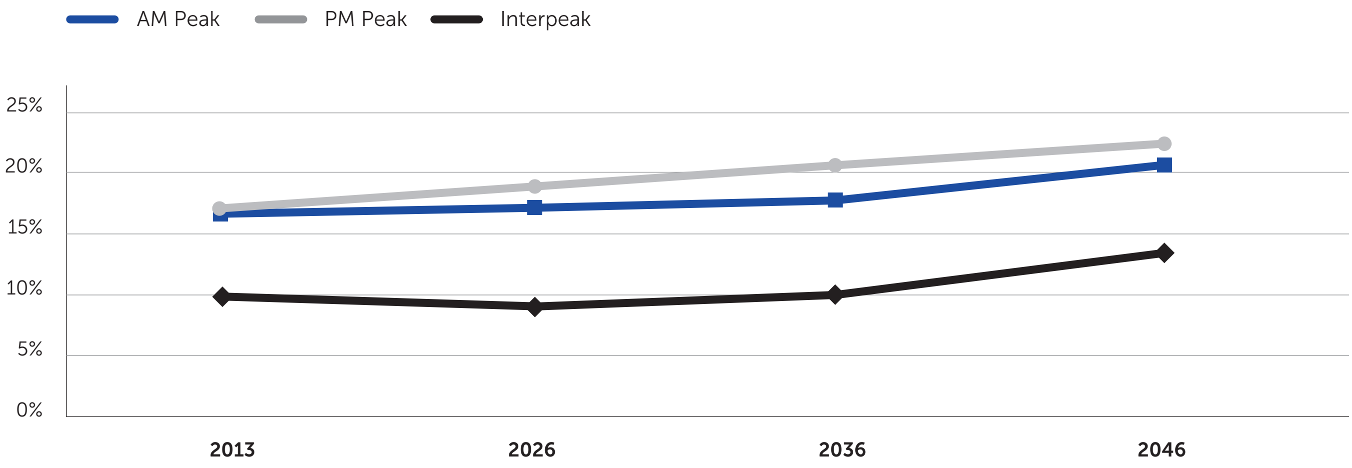
**FIGURE 16: GROWTH OF SEVERE CONGESTION IN THE MORNING PEAK: 2016 (LEFT) COMPARED TO 2046 (RIGHT)**




*Source: Auckland Forecasting Centre, Macro Strategic Model outputs*

Figure 17 below shows the change in proportion of vehicle travel subject to severe congestion (ie moving at less than 30% of posted speed limits) over time. These regional average performance figures include the effects of construction of new road capacity to support greenfield growth and uncongested rural roads. As a result, they are likely to mask higher congestion impacts at a sub-regional level. As the maps in Figure 16 indicate, conditions within the existing urban area are likely to be considerably worse than the regional average figures suggest.

## FIGURE 17: PROPORTION OF REGIONAL VEHICLE KILOMETRES TRAVELLED IN SEVERE CONGESTION




*Source: Auckland Forecasting Centre, Macro Strategic Model outputs*

### 3.2.2 Forecast labour force accessibility

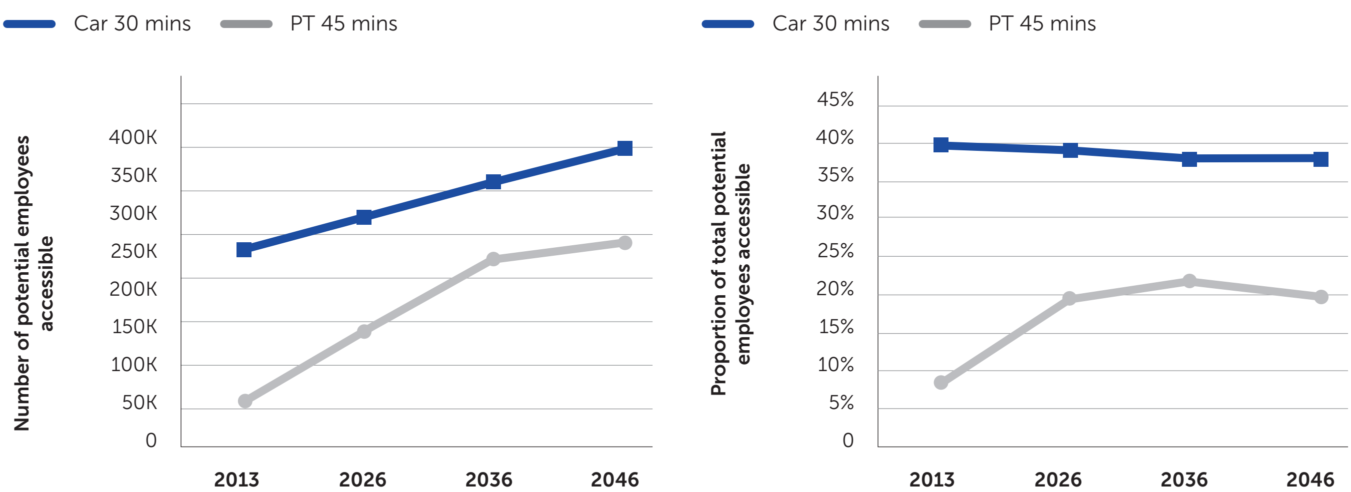
Looking forward, Auckland's total labour force is projected to increase by around 280,000, or 40%, over the next 30 years. However, the potential number of employees available to a business within a 30-minute car trip only increases by 73,000, or 30%, over the next 30 years (see Figure 18). This means that 70% of the new working population is expected to be located more than 30 minutes (by car) from prospective employment opportunities. Although access to the labour force by public transport improves, cars are expected to remain the main mode by which people get to work, accounting for 69% of commuting trips in 2048.

Consequently, the increases in congestion and slower travel times mean that many of the potential benefits from Auckland's growth, such as the increased productivity that would arise from a larger and more connected labour force, are likely to be limited.

## FIGURE 18: ACCESS TO THE LABOUR POOL IN THE MORNING PEAK

**Access to the labour pool: Number of potential employees accessible within a reasonable travel time (AM peak)**

**Access to the labour pool: Proportion of total labour pool accessible within a reasonable travel time (AM peak)**

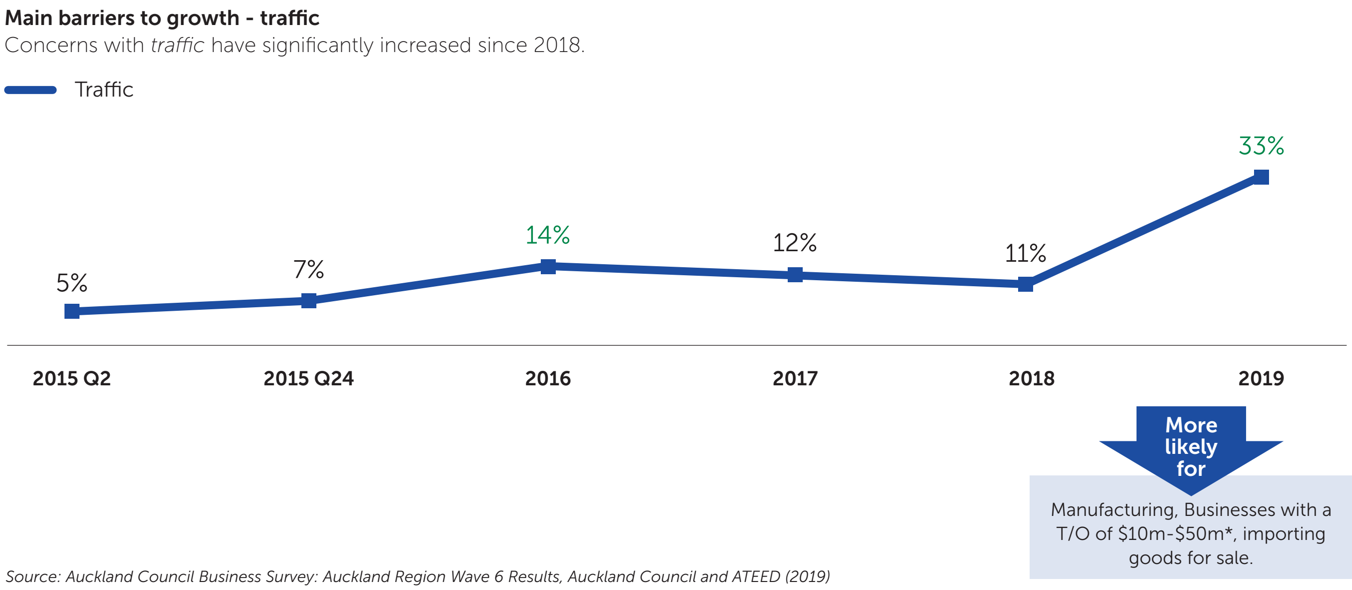



*Source: Auckland Forecasting Centre, Macro Strategic Model outputs*

## 3.3 Auckländer's perceptions

The results from the 2019 Auckland Council and Auckland Tourism, Events and Economic Development (ATEED) Business Survey reveal a dramatic rise in the number of businesses that are concerned about the impact traffic congestion is having on business confidence. The survey found that 33% of respondents have concerns that traffic in Auckland is a barrier to growth, compared with less than 10% of respondents in 2015 (see Figure 19). Traffic is now identified as an impediment to operations by more respondents than any other factor, including concerns such as finance/costs and staff (see Figure 20).

### FIGURE 19: PROPORTION OF BUSINESSES IDENTIFYING TRAFFIC AS A BARRIER TO GROWTH

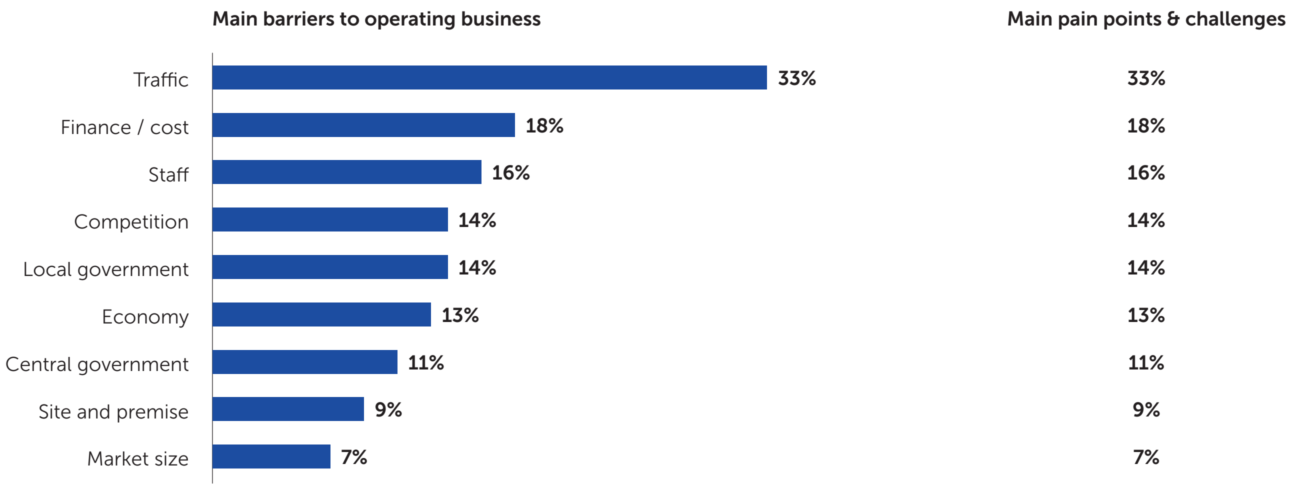



*Source: Auckland Council Business Survey: Auckland Region Wave 6 Results, Auckland Council and ATEED (2019)*

## FIGURE 20: FACTORS IDENTIFIED BY BUSINESSES AS BARRIERS TO OPERATIONS (% OF RESPONDENTS)

**Main barriers to operation**

Factors like *competition, economy and market size* are less of a main pain point compared to *traffic, finance/costs* and *staffing* issues.



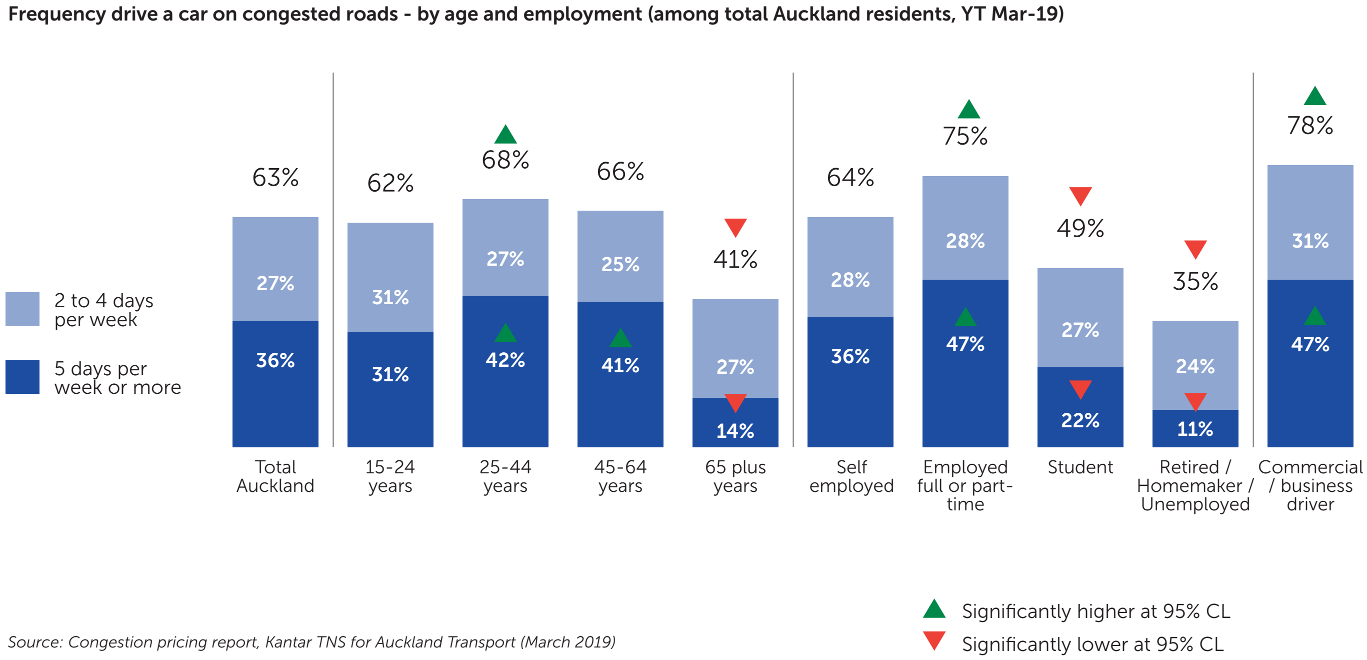

*Source: Auckland Council Business Survey: Auckland Region Wave 6 Results, Auckland Council and ATEED (2019)*

Auckland Transport conducts regular customer surveys based on 2,000 interviews per annum, with fieldwork conducted quarterly.

In the year to March 2019, the survey indicated that a large majority of Auckland residents in employment and commercial drivers are affected by congestion most days of the week. These proportions have increased since the last reporting period as indicated by the green arrows (see Figure 21).

## FIGURE 21: FREQUENCY OF DRIVING ON CONGESTED ROADS

**Half of Auckland residents in employment and commercial / business drivers are affected by road congestion most days of the week.**

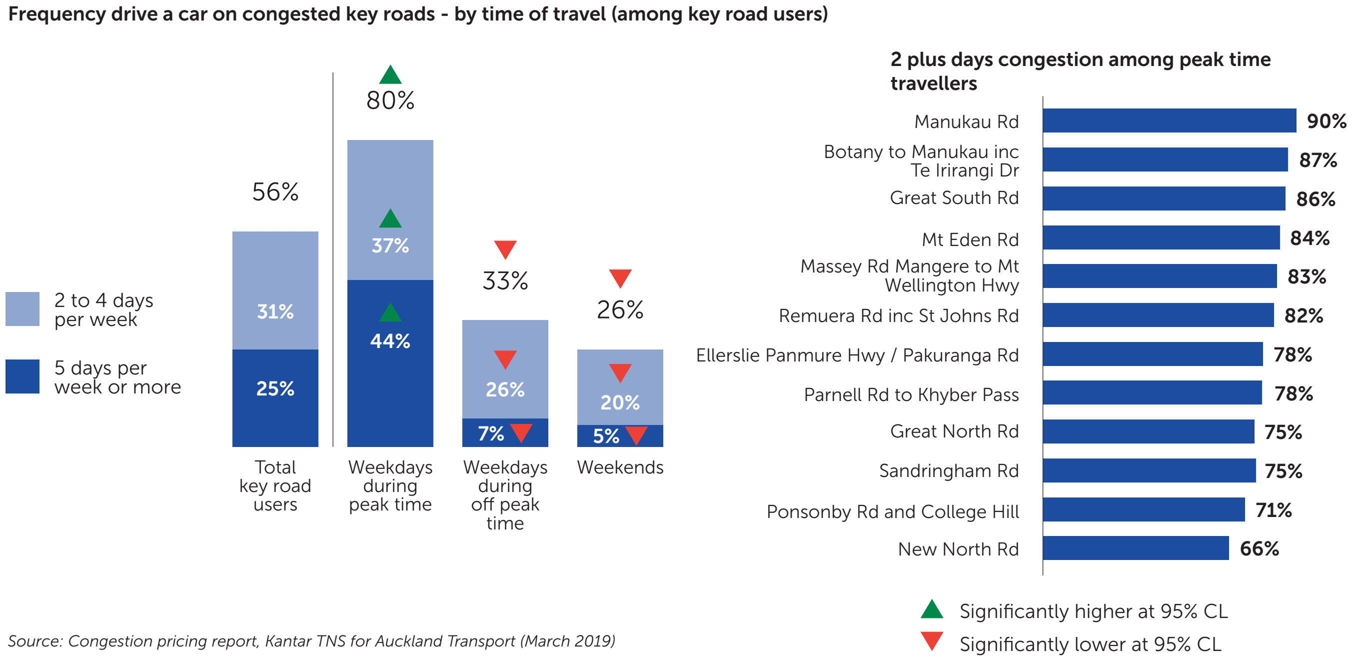



*Source: Congestion pricing report, Kantar TNS for Auckland Transport (March 2019)*

The survey also provides a picture of traffic conditions on key Auckland arterial roads. Of people who travel in peak periods on weekdays, 80% noted they were experiencing traffic congestion on key Auckland roads, and this incidence had increased since the last reporting period as indicated by the green arrows (see Figure 22).

**FIGURE 22: TRAFFIC CONDITIONS ON KEY ARTERIAL ROADS**

**Congestion is also a common occurrence for those travelling during peak time along the key roads and indicatively is an issue across all key roads.**




*Source: Congestion pricing report, Kantar TNS for Auckland Transport (March 2019)*

## 3.4 Congestion costs in Auckland

The observed deterioration in network performance has a direct impact on economic productivity and long-term competitiveness. How much traffic conditions are impacting Auckland's current economic performance is the subject of two studies undertaken on local congestion costs.

### 3.4.1 Wallis and Lupton (2013)[9]

A study of aggregate congestion costs in Auckland by Wallis and Lupton (2013) used a definition of congestion based on the engineering definition, as 'occurring when the demand for the road exceeds its capacity – ie the maximum sustainable flow'. The report goes on to define the cost of congestion as 'the difference between the observed travel time and the travel time when the road is operating at capacity – plus schedule delay costs, reliability costs and other applicable social and environmental costs'.

The report used the Auckland Regional Transport Model (ART3) for data inputs and adjusted prices to 2010. It estimates that the cost of congestion to Auckland is $1,250 million per year when compared with free-flow conditions, and $250 million per year when compared with the network operating at capacity.

9 NZ Transport Agency research report 489, Ian Wallis and David Lupton (2013)

### 3.4.2 New Zealand Institute of Economic Research (2017)[10]

A more recent study of aggregate congestion costs in Auckland by the New Zealand Institute of Economic Research (NZIER) in 2017 attempted to extend the analysis and considers the impacts beyond the direct time savings to freight operators and commuters. The calculation considered the benefits associated with reducing congestion that also accrue to all businesses that use transport and employ workers who commute and to households who waste their scarce time driving in congested conditions.

NZIER estimated the benefits of decongestion to network capacity levels in Auckland would be between $0.9 billion and $1.3 billion per annum (approximately 1–1.5% of Auckland's gross domestic product (GDP), based on 2016 prices). These estimates represent the economic and social benefits[11] to Auckland if the road transport network was operating at its capacity, Monday to Friday. The estimate of benefits from reducing congestion to levels that would maximise flow to network capacity levels includes the flow-on impacts across the economy plus social benefits such as reduced carbon emissions. The estimates do not include the benefits of decongestion in the weekends, which if included, would increase the value of the estimated benefits.

NZIER note that their estimate is likely to be conservative as there are several other potential benefits from decongestion that have not been included due to data, time and resource constraints. These include:

- Auckland's overall liveability
- greater choice in work location (better skill matching around the Auckland region)
- greater choice in household location (increased accessibility to jobs, services and leisure)
- greater freedom for businesses to locate around Auckland (trading off labour market access and rental costs).

## 3.5 Environmental performance

Vehicles burning petrol and diesel contribute to greenhouse gas emissions and also emit a range of harmful pollutants. In Auckland, road transport is a significant year-round contributor to concentrations of air pollutants like $PM_{2.5}$, $PM_{10}$, $NO_x$ and volatile organic compounds (VOC). Emissions from road transport in Auckland are generally higher than other locations in New Zealand.

Auckland Council's greenhouse gas emissions inventory found that in 2016, road transport emissions contributed 37.6% of total greenhouse gas emissions in Auckland (see Figure 23), as a product of fuel consumption and vehicle kilometres travelled (VKT).

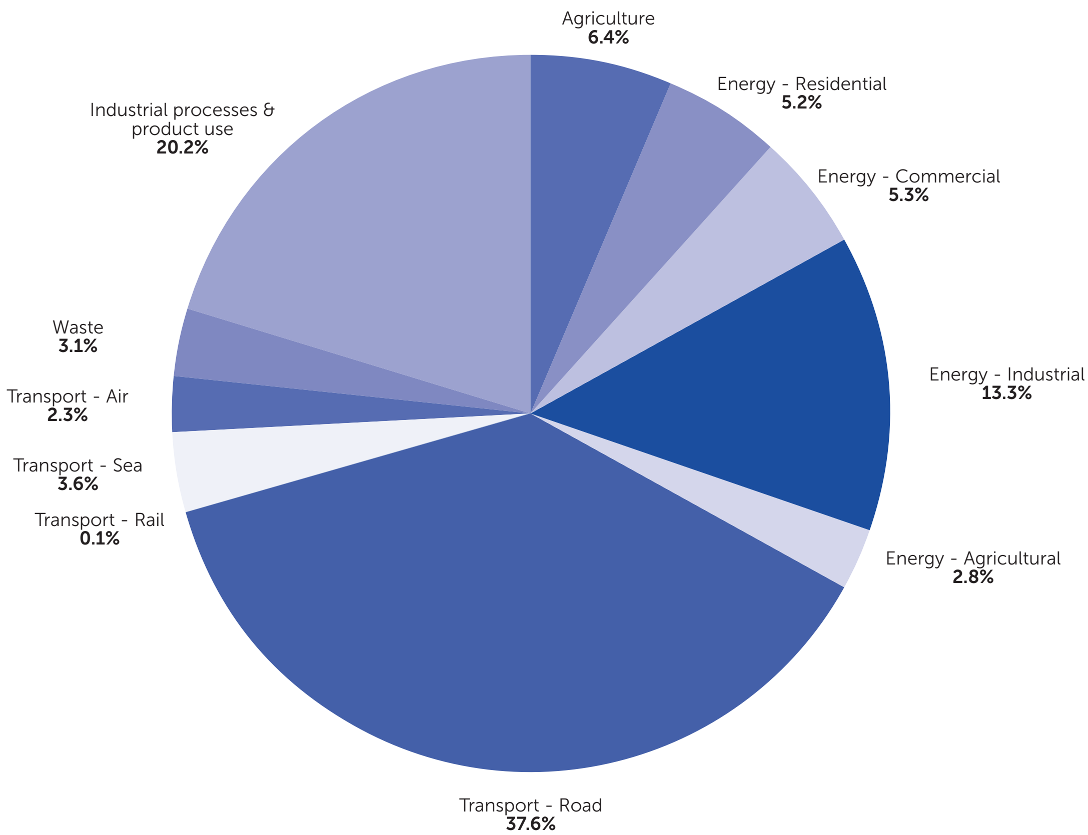
Auckland Council's emissions inventory found that road transport accounts for 32% of total $PM_{10}$ emissions, and 67% of regional $NO_x$ emissions[12]. These pollutants have significant health impacts. Levels of pollutants vary greatly across the region depending on factors such as the season but, generally, the highest levels of pollutants are from vehicles in the city centre area.

The steady rise in peak-period congestion across Auckland's arterial network has contributed to increased idling times that impact the rate of emissions. By comparison, free-flowing traffic emits less pollution per kilometre travelled than congested or stop-start traffic, because vehicles are moving at a more-or-less constant speed, and engines are operating at a 'cruise' speed. This has two effects: less frequent acceleration generates lower emissions than stop-go acceleration for brief periods, and the turbulence created by vehicles helps to disperse pollutants (particularly in poorly ventilated locations, like tunnels and street canyons).

10 Benefits from Auckland road decongestion, New Zealand Institute of Economic Research (2017)
11 These benefits accrue across three sectors: government, business and household. The benefits to households are estimated to be between $233 million and $382 million per year. This represents an economic benefit of approximately $500 – $750 per household.
12 Environmental Outcomes: Initial Assessment, TCQ Working Paper (2019)

Contaminated run-off from roads also contributes to environmental concerns, reducing water quality in Auckland streams, rivers and estuaries. Heavy metals like copper, found in brake pads, collect on roads and make their way into streams where they can have toxic impacts on aquatic species.

**FIGURE 23: AUCKLAND'S GREENHOUSE GAS EMISSIONS (2016)**




*Source: Environmental Outcomes: Initial Assessment, TCQ Working Paper (2019)*

## 3.6 Main findings

The analysis shows that the performance of the Auckland network has resumed its decline following the improvement associated with the Waterview Tunnel opening in July 2017. Congestion maps demonstrate that large sections of the strategic roading network are now experiencing congested conditions during the morning and afternoon peak periods.

Future investment in new infrastructure and additional public transport services are expected to make a critical contribution to meeting the travel needs of Auckland's residents and businesses, but without some form of


demand management tool, congestion will continue to increase. Detailed transport modelling undertaken by TCQ indicates that continued rapid population growth is projected to lead to increases in demand for travel, with total daily trips by all modes rising from 5.4 million in 2016 to 7.8 million by 2046, an increase of 44%.

Although public transport and active mode shares are forecast to increase significantly, supported by large investment programmes, the distance travelled by private vehicles is still expected to grow by 50% – increasing the pressure on the road network. This translates into double the number of motorway lane kilometres subject to severe congestion and congestion spreading from the Bombay Hills in the south to Redvale in the north.

The deterioration in network performance means that Aucklanders' access to jobs, education and other opportunities will become more difficult, constraining growth and limiting the competitiveness of the regional economy. This has been confirmed by a recent study by NZIER, which estimates the benefits of decongestion in Auckland would be between $0.9 billion and $1.3 billion per annum (approximately 1-1.5% of Auckland's GDP, based on 2016 prices).

The steady rise in peak congestion across Auckland's arterial network has also contributed to increased vehicle emissions and local pollution. A move to implement congestion pricing will generate environmental benefits through a reduction in vehicle kilometres travelled, and a reduction in time spent idling. This has positive flow on environmental benefits for greenhouse gas emissions, and air and water quality.

Part two

# CONGESTION PRICING THEORY AND PRACTICE

**This section provides an overview of traffic congestion principles, introduces the economic theory of congestion pricing, and presents a review of overseas experience with congestion pricing. It also outlines the key areas that need to be considered prior to developing a potential congestion pricing scheme for Auckland. The purpose is to develop the building blocks required to enable Auckland to consider options that will deliver a programme that is feasible, and delivers economic, social and environmental benefits.**

4. **Congestion and Congestion Pricing:** describes congestion, discusses congestion costs, and provides an overview of the theoretical basis for levying congestion charges.

5. **International Review:** provides a survey of overseas experience with congestion pricing to derive the key lessons learned from successful and unsuccessful programmes.

6. **Congestion Pricing Policy:** provides a detailed examination of the main elements that make up a congestion pricing policy that determines the pricing structure that motorists could face.

7. **Community Considerations:** discusses congestion pricing from the perspective of the community.

8. **Technology Options:** discusses the technology options potentially available to implement a congestion pricing scheme in Auckland.

# 4 CONGESTION AND CONGESTION PRICING

This section introduces the concept of traffic congestion and describes its causes, how it can be measured, and why it is a problem. This section also provides a brief overview of the theoretical basis for congestion pricing and discusses how motorists respond when pricing is introduced. Although traffic systems are hugely complicated and the complexities of measuring and modelling demand and supply should not be underestimated, the economic literature provides a sensible starting point when considering the implementation of a congestion pricing scheme.

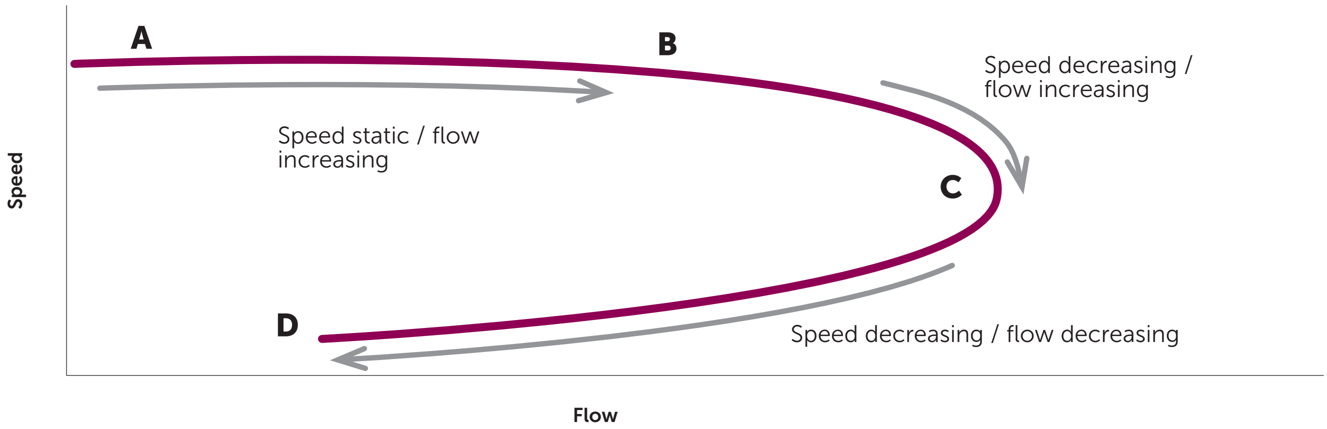
## 4.1 Defining congestion

### 4.1.1 Objective measures

Traffic congestion is a condition on road networks that occurs as use increases to match and exceed the capacity of a road segment. It is characterised by slower speeds, longer and more variable trip times and increased vehicular queuing. When traffic demand is large enough for the interaction between vehicles to slow the speed of the traffic, congestion begins to occur. As demand approaches the capacity of a road (or of the intersections along the road), congestion emerges and increases rapidly.

Work undertaken both in New Zealand[13] and overseas[14] shows a clear relationship between traffic speeds and traffic volume or flow as shown in Figure 24. This relationship is commonly referred to in traffic engineering as the speed-flow curve.

**FIGURE 24: SPEED-FLOW RELATIONSHIP FOR TRAFFIC**




*Source: Costs of congestion reappraised. NZ Transport Agency research report 489, IP Wallis and DR Lupton (2013)*

13 Costs of congestion reappraised. NZ Transport Agency research report 489, IP Wallis and DR Lupton (2013)
14 Transportation Research Circular E-C149: 75 Years of the Fundamental Diagram for Traffic Flow Theory, Transportation Research Board (2011), USA

As Figure 24 illustrates, when there is a low traffic flow (point A), vehicles are able to travel at a constant speed – referred to as the 'free-flow' speed. This speed is maintained as traffic flow begins to slowly increase (between points A and B). As vehicle numbers rise, they increasingly interact with each other and reduce the speed at which they can all travel. Despite this decrease in speed, and due to factors such as the decreased space required between each vehicle when travelling at a slower speed, the volume of traffic along the stretch of road can continue to increase (between points B and C).

However, beyond a certain level of traffic flow (beyond point C on the chart), each additional car that joins the stretch of road will have both an adverse impact on the capacity of the road and the speed at which vehicles can travel. Beyond point C – the maximum capacity for the stretch of road – the flow of traffic breaks down because of the interactions between the vehicles and speed and flow continue to reduce (between points C and D).

This objective relationship is well established and is an important concept in traffic engineering. However, while it is measurable and provides an understanding of the phenomenon, as congestion is an abstraction, it does not have a defined starting point.

### 4.1.2 Subjective measures

Also important to the formalised and measurable objective phenomenon of congestion is the concept of perceived or subjective congestion.

While the objective description of how congestion develops is generally agreed, actual perceptions of congestion can differ substantially. This perception of congestion, and level of dissatisfaction with it, will depend on people's personal experiences and expectations. For instance:

- A person from outside Auckland may consider a motorway travelling at 50–60 km per hour highly congested; however, a regular driver on that route who frequently experiences portions of their commute at 30 km per hour (or even lower) would consider this relatively uncongested.
- The level of traffic and delay a person could experience before considering they are in congestion on a rural road would likely be far less than on a major urban arterial.
- Likewise, the acceptability of travelling at 60 km per hour on a motorway at 4:30pm would significantly differ from travelling the same speed at 4:30am.

Perceived congestion therefore could begin at any downwards point along the speed-flow curve depending on the person asked, the time, type and priority of trip being undertaken, and the specific spatial and temporal situation. For this reason, perceived congestion is generally not suitable to use in determining an absolute measure but can be an important perspective to consider in the design and development of any congestion pricing scheme.

## 4.2 Types of congestion

The economist William Vickrey identified six causes of congestion, and his work[15] is considered the starting point for the modern study of congestion:

1. **Simple interaction on homogeneous roads:** where two vehicles travelling close together delay one another (effectively where one slower vehicle causes vehicles following it to be delayed).
2. **Multiple interaction on homogeneous roads:** where the effect of different speeds of vehicles causes delay (often seen on motorways when traffic volumes get heavy and vehicles speed up or slow down to change lanes).
3. **Bottlenecks:** where more vehicles are trying to pass through a point on a road where capacity reduces to be less than the upstream capacity.
4. **Trigger-neck congestion:** where a source of congestion generates a queue of vehicles, which in turn delays a vehicle trying to pass through part of the queue on a journey in a different direction (eg to enter a turning bay).
5. **Network control congestion:** where traffic signals, roundabouts or give way/stop signs used for safety and traffic management at intersections start to generate queues in other directions of flow, or indeed the main flow.
6. **Congestion due to network changes:** where attempts to manage congestion (eg by increasing capacity) in one location may cause an increase in downstream congestion, because the upstream capacity has been increased but not matched by downstream capacity relative to demand.

Historically, when roads became congested, the preferred policy approach was to widen them to increase capacity. While this may have provided some immediate extra capacity and reduced delays in the short term, over time, depending on the circumstances, the improvement increased the attractiveness of the locations it served, generating additional trips until congestion returns to levels similar to those existing before the additional capacity was added[16].

## 4.3 Congestion costs

Traffic congestion affects users of the road network in that it delays journeys and makes journey times unpredictable because of the volatile nature of travel times in response to small changes in traffic demand. These increased travel times limit access to economic, educational and social opportunities. Direct costs of traffic congestion to individuals include increased fuel and vehicle maintenance costs, loss of time (due to sitting in traffic), and schedule delay costs (having to change time of travel to avoid delay).

In most spheres of our lives, when demand for a product or service exceeds supply, the price rises to a level where demand and supply meet (eg the price of strawberries on Christmas Eve or the price of airline flights during the school holidays). This is not the case for roads (and some other utilities), where the monetary cost of driving does not usually vary by time or location.

Travelling on a congested road increases the overall cost that drivers face. This not only includes the cost of additional time, fuel and maintenance costs, but also includes the additional costs of accounting for the variability of travel times. The decision to travel by an individual driver is based on their own perceived travel costs (private or internal costs). Their decision does not consider the impact to all other car users (external costs). When private costs are less than the full costs (internal and external) of driving, this is inefficient and consequently too much of a good (in this case travel) may be consumed. Drivers continue to choose to travel during peak periods and, once a section of the road network reaches capacity, each additional vehicle that attempts to join the road will reduce the speed that vehicles can travel, increase the time (and variability in time) it takes to travel and have an exponential impact on the level of congestion that everyone experiences.

15 Congestion Theory and Transport Investment, William Vickrey, American Economic Review (1969)
16 Why it's time for congestion charging, Marion Terrill, Grattan Institute (2019)

## 4.4 Theory of congestion pricing

The economic theory of congestion pricing was developed in 1920 by Arthur Pigou[17] to illustrate the economics of external effects and the ability of taxation to restore efficiency when goods are not optimally priced[18].

Unregulated congestion entails an efficiency loss and a corresponding possibility for obtaining a welfare gain. This gain can be achieved through pricing, decentralising the decision about who should travel when and where. In the first step of the analysis, the price should equal the value of the delay that a marginal car imposes on other travellers. The size of the total delay associated with the marginal car is determined from traffic models, ranging from simple supply curves to complex traffic models.

A congestion charge is intended to correct for the externalities of congestion, such as increases in travel time, traffic accidents, environmental pollution, and fuel consumption, by confronting users with the costs imposed on other users. In doing so, two potential sources of efficiency gains are identified:

1. Deadweight losses – classical static models of congestion show that road pricing can reduce the deadweight losses that arise from excess demand and the congestion externalities that result.
2. Monetisation of delays – dynamic bottleneck models of congestion show that road pricing monetises delays and encourages drivers to adjust departure times.

The standard rationale for congestion pricing is based on a range of explicit or implicit simplifying assumptions. Research on what happens if these simplifications are removed demonstrates that allowing for more complexity in the analysis further strengthens the economic case for congestion pricing[19].

## 4.5 Response to congestion pricing

### 4.5.1 Individual responses

The primary aim of introducing congestion pricing is to change people's behaviour and subsequently allow part of the road network to operate more efficiently. For congestion pricing to work, it requires a behavioural change for some people to change the way they travel. In the short term, this could be:

- Do nothing – people continue with their previous routes and pay the higher price.
- Shift routes – people find an alternative route with no charge or a lower charge.
- Shift modes – people take an alternative form of transport: public transport, walking/cycling, carpooling to share costs, etc.
- Shift travel time – people shift their travel to a different time of day when the charge may be lower or there is no charge, potentially smoothing congestion away from the peaks.
- Avoid trips – people decrease the number of trips they make to avoid the charge, for example by online shopping, or combining multiple trips into one. This is especially relevant for many discretionary trips.

17 The Economics of Welfare, A Pigou, London, UK: MacMillan (1920)
18 A Handbook of Transport Economics: Road Congestion Pricing, G Santos & E Verhoef, edited by: A de Palma, R Lindsey, E Quinet & R Vickerman, Edward Elgar Publishing Limited (2011)
19 Road Pricing with Complications. In Implementing Congestion Charges – OECD/ITF Round Table 147, M Fosgerau & K Van Dender, Paris, France: OECD Publishing (2010)

Longer-term behavioural changes might be:

- Choose a different destination – people opt to travel to a different location to avoid or minimise the charge. This may include changing place of work/school/ shopping etc.
- Choose a different origin – people opt to move their home/business location to avoid or minimise the congestion charge.

Overseas evidence shows that while most people tend to pay the charge and continue driving[20], because the relationship between traffic speeds and flow is non-linear, it only takes a small reduction in vehicle volumes to have a significant impact on congestion. The idea of congestion pricing is to target the lowest value trips (including discretionary trips) that could be deferred or re-timed, freeing up the roads for those who need to travel.

## 4.5.2 Public perception

Overseas evidence suggests many people will not perceive, or at least will not perceive fully, the extent of behavioural change that they have actually made in response to a congestion charge. A 2006 study undertaken in Stockholm following the introduction of its scheme asked people about the changes they had made to their travel. The researchers were surprised to find that a significant portion of the trips that were no longer occurring were unaccounted for. In fact:

> *"Most drivers were unaware that they had reduced their trips across the cordon. A comparison of drivers' stated change in behaviour and objective traffic measurements showed that around three-quarters of the decrease in trips had apparently gone unnoticed by drivers*[21]*."*

It is likely that people will, for at least some of the time, not realise they have made the choice to change their time or mode of travel, or to not make the trip at all. These decisions around the edges are the primary targets of any congestion pricing scheme and demonstrate the potential of even a relatively small charge – making people question the need to undertake that trip, potentially subconsciously, in the first place.

Experience shows that where road pricing has been introduced, the new norm is rapidly accepted, and pricing is then supported by the overall population affected.

20 Social and Distributional Impacts of Time and Space-based Road Pricing (final draft report), MRCagney (2018)
21 The Stockholm congestion charges: an overview, J Eliasson, KTH Royal Institute of Technology CTS Working Paper (2014)

However, concern over distributional effects is clearly legitimate whenever there are winners and losers from a public policy intervention. This matter is addressed in Sections 12 and 15.

Over time, the level of acceptance of a charging scheme is likely to increase, as has been observed in European cities where urban road pricing has been introduced (see Table 6)[22].

### TABLE 6: ACCEPTANCE OF CHARGING BEFORE AND AFTER IMPLEMENTATION IN FIVE EUROPEAN CITIES

| City | Before | After |
|---|---|---|
| Stockholm | 21% | 67% |
| Bergen | 19% | 58% |
| Oslo | 30% | 41% |
| Trondheim | 9% | 47% |
| London | 39% | 54% |

22 Congestion Charging: Policy and Global Lessons Learned, CURACAO Deliverable D3: Case Study Results Report (2009)

# 5 INTERNATIONAL REVIEW

TCQ commissioned research on overseas experience with congestion pricing to derive the key lessons learned to enable Auckland to consider options that are more likely to deliver a programme that is feasible, delivers benefits and has public acceptability[23].

Overseas cities that have implemented congestion pricing schemes include Singapore, London, Stockholm, Dubai, Valetta (Malta), Milan, Gothenburg and Bergen. There are a number of cities in the US that are investigating congestion pricing but have not yet moved to implementation. These include New York, San Francisco, Los Angeles, Portland (Oregon), Boston, Seattle and Washington DC.

This section provides a selection of relevant case studies of cities with current congestion pricing schemes, to consider in the Auckland context.

## 5.1 Types of congestion pricing schemes

There are conceptually four types of congestion pricing schemes:

1. **Cordon Charging:** vehicles are charged for crossing a ring or line of charge points across a series of roads at specific times of day, typically to manage demand. Cordon pricing does not charge for traffic movements within the cordon. Examples: Stockholm, Gothenburg.
2. **Area Charging:** vehicles are charged for crossing a ring or driving within that ring at specific times of day, typically to manage demand. Example: London.
3. **Corridor Charging:** vehicles are charged to use one or more roads in a specific congested corridor or corridors (main highways and secondary routes). Examples: Singapore, Dubai.
4. **Network Charging:** vehicles on a road network are charged based on a combination of the time of day, location and distance travelled. This potentially requires using in-vehicle Global Navigation Satellite System (GNSS) hardware, but this may not be required. Example: Proposed for Singapore.

23 Review of international pricing initiatives, previous reports and technologies for demand management purposes, D'Artagnan Consulting (2017)

## 5.2 Case study: Stockholm

Stockholm introduced a cordon charge scheme in 2007, with prices varying between peak and off-peak. This came after a comprehensive pilot, which effectively trialled the full scheme for six months, exposing the public to the impacts of the scheme. The pilot was followed by a public referendum, the results of which provided a narrow mandate to proceed.

Today the scheme generally has a high degree of public acceptance and has largely sustained the benefits of its introduction, with charges increased once, and an expansion of the scheme to charge through-traffic. Most of the net revenue has been used to fund major urban road improvements (including a bypass route to the charging zone), but more recently has also been used to fund public transport and cycling infrastructure.

The scheme is summarised in Table 7, with a map of the area involved shown in Figure 25.

### TABLE 7: STOCKHOLM CONGESTION CHARGE SUMMARY

| Stockholm Congestion Charge | |
|---|---|
| **Year** | 2007 (after six month pilot in 2006) |
| **Authority** | Swedish Transport Agency |
| **Scheme** | Cordon around central Stockholm and motorway through cordon, with 18 charging points |
| **Description** | Population: 2m; Toll Zone: 35km$^2$; 65% of population live within Toll Zone; 67% PT, cycle and walk mode share |
| **Objectives** | Reduce traffic congestion, improve urban environment, and supports urban highway projects and PT infrastructure |
| **Implementation** | Referendum held after pilot period received majority support in Stockholm and rejected by 14 surrounding municipalities. The pilot included an expansion of bus services to accommodate mode shift. |
| **Technology** | Vehicles passing control points identified through automatic number plate recognition (ANPR). Equipment and information signs are mounted on gantries. There are no toll booths or manual payment facilities. |
| **Vehicles** | All cars, freight vehicles and buses with gross vehicle weight of less than 14 tonnes |
| **Tariff** | Cordon entry and exit varied by time of day and location |
| **Payment** | Post-payment by invoice |
| **Link with Tax** | None |
| **Exemptions** | Emergency vehicles, mobile cranes, motorcycles, mopeds and buses. No charge on Saturdays, Sundays, nights, public holidays, nor July |
| **Charges** | SEK11 - SEK35. The maximum congestion tax payable per day is SEK 105 per vehicle (1NZD = 6 SEK) |
| **Financials** | Generated 850 MSEK of revenue in 2013 with estimated yearly operational costs of 220 MSEK representing 25% of revenues. |
| **Revenues** | Supports new urban highway projects and public transport infrastructure |
| **Impact** | Overall reduction in the amount of non-exempt traffic across the congestion charge zone has remained stable at around 20%, while travel times and trip reliability improved dramatically for both drivers and PT users. Transit ridership increased by 4-5% and vehicle emissions in the inner city, reduced by between 10 and 15%. Public support for congestion charges grew from 36% in 2006 to nearly 70% in 2011. |
| **Other** | Six month pilot changed public opinion about the effectiveness of road charging in delivering behaviour charge to reduce congestion and improve local environment. |

*Source: Review of international pricing initiatives, previous reports and technologies for demand management purposes, D'Artagnan Consulting (2017)*

**FIGURE 25: STOCKHOLM CONGESTION CHARGE MAP**


The map shows where the limits are for the congestion tax zones. The red dots indicate where the control points are located.

*Source: Review of international pricing initiatives, previous reports and technologies for demand management purposes, D'Artagnan Consulting (2017)*

## 5.3 Case study: Gothenburg

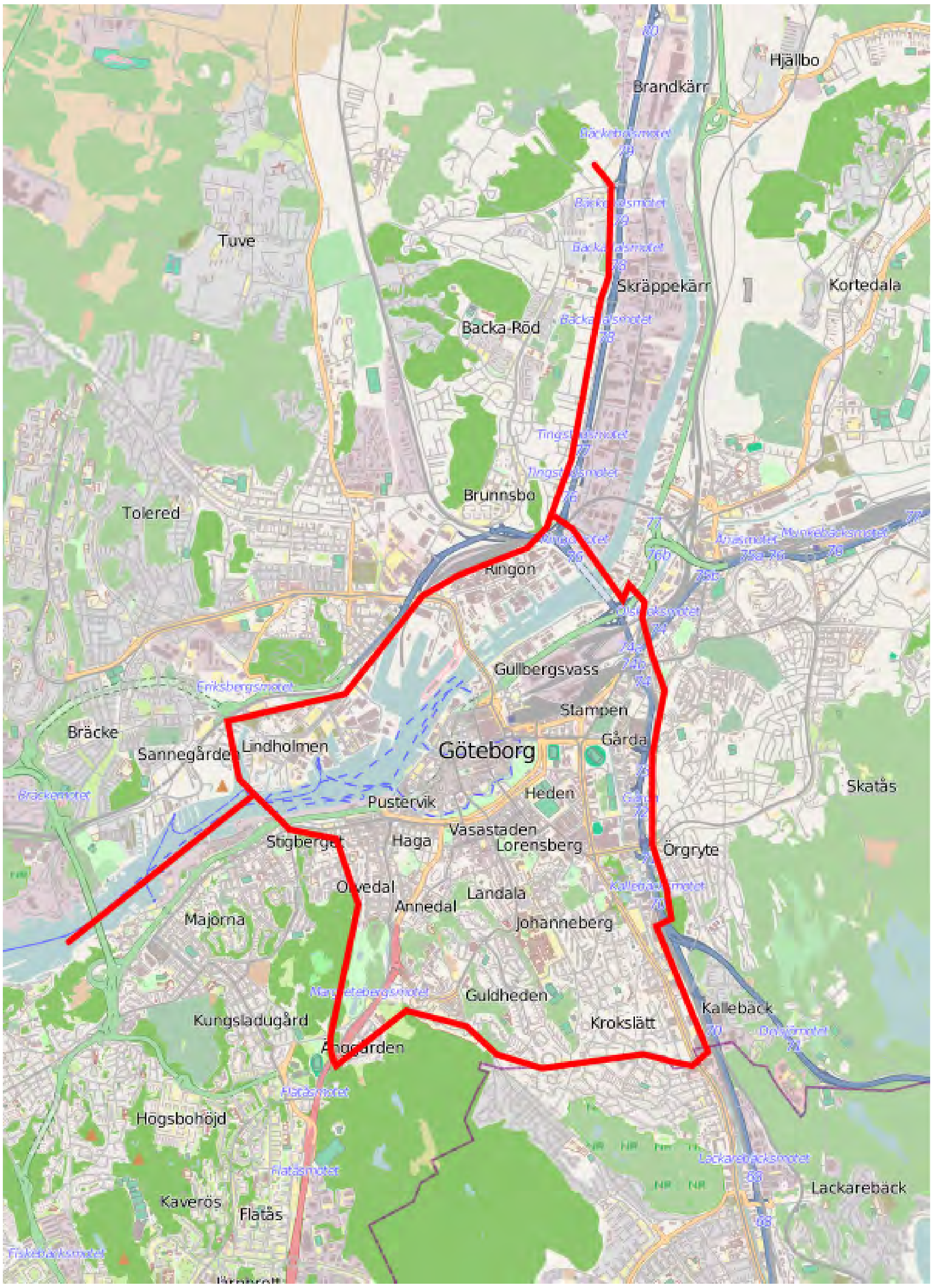
Gothenburg introduced congestion pricing in 2013, which makes it one of the most recent jurisdictions to introduce a charging scheme. Compared to Stockholm, Gothenburg has less serious congestion and a lower use of public transport (along with a smaller population and distinctly different geography). Gothenburg's scheme also has lower levels of public acceptance, not assisted by the fact that the scheme was designed principally to maximise revenue to fund a package of transport investments (including projects primarily benefiting intercity rather than urban travel), rather than to target congestion. The scheme is summarised in Table 8 and Figure 26.

**TABLE 8: GOTHENBURG CONGESTION CHARGE SUMMARY**

| Gothenburg Congestion Charge | |
|---|---|
| **Year** | 2013 |
| **Authority** | Swedish Transport Agency and Swedish Transport Administration |
| **Scheme** | Cordon around central Gothenburg and a number of main roads, with 38 charging points |
| **Description** | Population: 982K; Toll Zone: 70km$^2$; 56% of population live within Toll Zone; 26% PT, cycle and walk mode share |
| **Objectives** | Reduce traffic congestion, improve urban environment, and fund large road and rail construction projects in Gothenburg area. |
| **Implementation** | The scheme received broad political support because Gothenburg (like Stockholm) would receive a major infrastructure package, funded by the congestion charging revenue leveraged with an equally large national grant. A consultative referendum was held in September 2014, where 57% voted against congestion charges, although the Gothenburg city council decided to keep the charges in spite of the referendum result. |
| **Technology** | Based on Stockholm Congestion Charge Scheme |
| **Vehicles** | All cars, freight vehicles and buses with gross vehicle weight of less than 14 tonnes |
| **Tariff** | Cordon entry and exit varied by time of day and location |
| **Payment** | Post-payment by invoice |
| **Link with Tax** | None |
| **Exemptions** | Emergency vehicles, mobile cranes, motorcycles, mopeds and buses. No charge on Saturdays, Sundays, nights, public holidays, nor July |
| **Charges** | SEK9 - SEK22. The maximum congestion tax payable per day is SEK60 per vehicle and when a vehicle passes more than one control point within 60 minutes only the highest tax is paid. (1NZD = 6 SEK) |
| **Financials** | The scheme generated revenue of 71 million EUR during its first year in 2013. The operating cost of the system including costs for maintaining the technical system, customer service and invoicing, is approximately 0.2 EUR per charged passage. In total 62 million passages were charged in 2013, implying a system cost of 12.4 million EUR per year. This corresponds to 17% of revenues. |
| **Impact** | Traffic across the cordon was reduced by 12% during the charged hours and travel times were significanly reduced for arterial roads, and in the wider Gothenburg area car traffic reduced by around 4%. Public transport trips increased by 6%, and emisisons declined from car traffic, such as nitrogen dioxide ($NO_2$). |

*Source: Review of international pricing initiatives, previous reports and technologies for demand management purposes, D'Artagnan Consulting (2017)*

## FIGURE 26: GOTHENBURG CONGESTION CHARGE SCHEME MAP




*Source: Wikipedia*

## 5.4 Case study: Singapore

Singapore was the first jurisdiction to introduce congestion pricing and it currently operates the most sophisticated and effective system of any city. It started by introducing a paper-based area licensing scheme in the central business district in 1975 and progressed to today's cordon, arterial and expressway-based scheme in 1998. This involves around 80 charging points covering two adjacent cordons and some strategic corridors. The prices at each charging point are reviewed every three months to ensure speeds on the routes that are charged are within the ranges of 45-65 km per hour for expressways and 20-30 km per hour for local streets. When the average speed drops below the bottom of the target range, the price is increased, and if the average speed exceeds the top of the range it is reduced. The system uses a combination of toll tags and roadside gantries equipped with readers and Automatic Number Plate Recognition (ANPR) cameras to detect vehicles and support enforcement. The scheme is summarised in Table 9 and Figure 27.

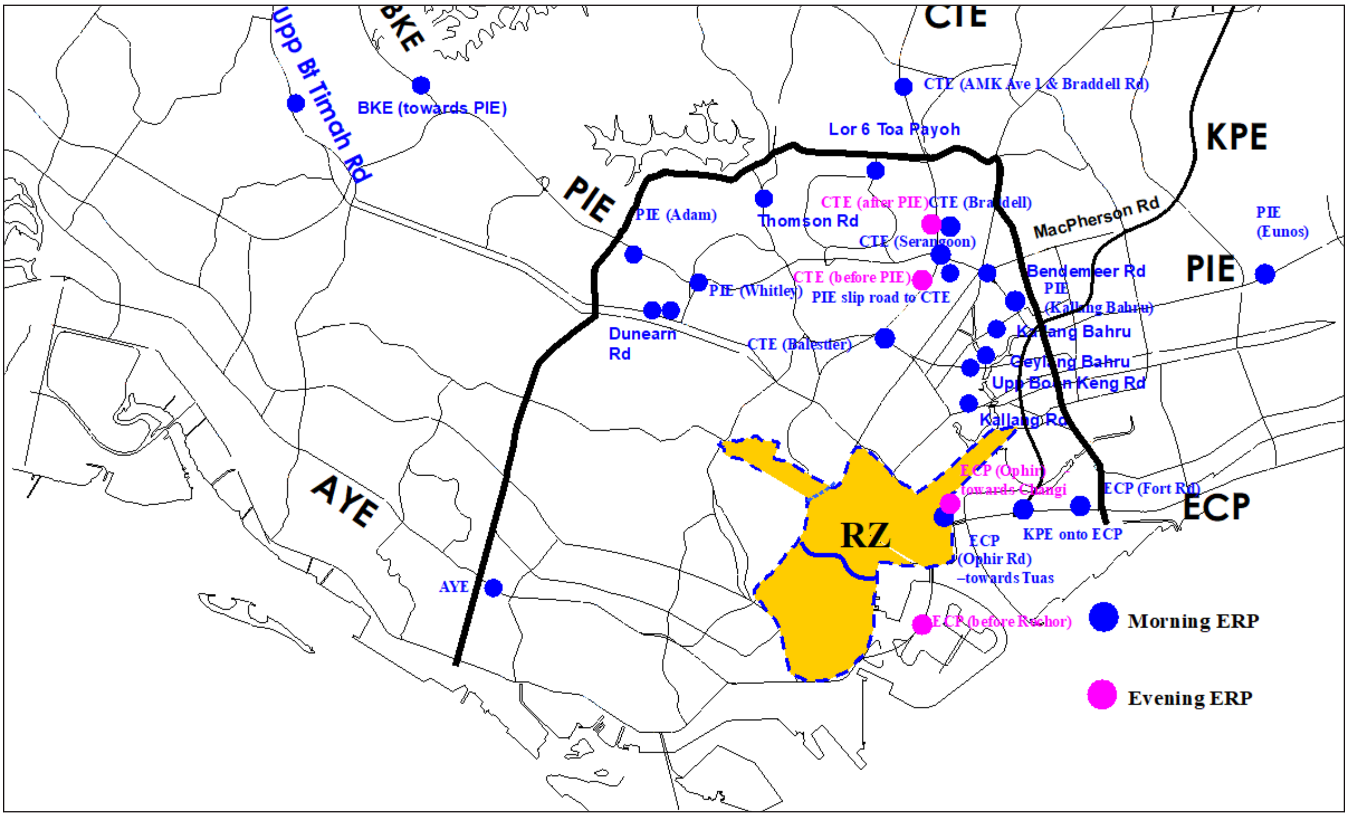
Singapore plans to be the first jurisdiction to introduce a GNSS-based urban congestion pricing scheme using in-vehicle hardware. The objective is to be able to support full network-based (distance, time and location and vehicle type) pricing in due course, but in the first instance, the technology will be used to replicate the existing pricing system and provide a platform to supply traffic, parking and transport option information to users. Depending on technology performance and reliability, the scheme could then evolve over time to apply charges on a more flexible basis. Gantry-based cameras will be retained for enforcement purposes.

### TABLE 9: SINGAPORE ELECTRONIC ROAD PRICING (ERP) SUMMARY

| Singapore Electronic Road Pricing (ERP) | |
|---|---|
| **Year** | 1998 |
| **Authority** | Land Transport Authority (LTA) |
| **Scheme** | Area wide congestion scheme that levies a time and location based fee for travel into the CBD including expressways, with 80 charging gantries. |
| **Description** | Population: 3.9m; Toll Zone: 50km$^2$; 25% of population live within Toll Zone; 67% PT, cycle and walk mode share |
| **Objectives** | To manage traffic and as a usage-based taxation mechanism to complement stringent car ownership rules and improvements in mass transit. |
| **Implementation** | Singapore was the first city in the world to implement an electronic road toll collection system for purposes of congestion pricing after successfully stress-testing the system as part of a technical pilot. |
| **Technology** | 30 ERP gantries located on all entry and main roads. Sensors installed on the gantries communicate with in-vehicle unit (IU) via a dedicated short-range communication system, and road usage fee deducted from pre-paid CashCard in the IU. The deducted amount is displayed to the driver on an LCD screen of the IU. Enforcement is primarily based on ANPR. The LTA has been testing a system based on GPS to replace the current technology. LTA state the GPS based ERP system will be operational from 2020 and will support management of traffic congestion and value-added services. |
| **Vehicles** | All motorcycles, cars, taxis, freight vehicles and buses |
| **Tariff** | Fees depend on the type of vehicle, checkpoint, day/time of entry. All trips recorded by ERP gantries are charged. The ERP operates from 7.30am to 8pm, and charges are not applicable on Sundays and Singapore Public Holidays. ERP rates are adjusted regularly to reflect traffic conditions with the goal of maintaining average vehicle speeds by route. |
| **Payment** | If a vehicle owner does not have sufficient value in their CashCard (or EZ-Link) the ERP charges an additional S$10 administration fee to be paid within two weeks of the notice. Online payment is allowed, otherwise, a penalty of S$70 is issued by registered post to the vehicle owner, which rises to S$1000, or one month in jail, if not settled within 30 days. |
| **Link with Tax** | Policy to shift progressively towards taxing on the basis of vehicle usage rather than ownership. This means that road taxes have been declining with the rise in ERP revenues and rates. LTA report that some 25% of total vehicle population of 850,000 vehicles pays ERP daily. |
| **Exemptions** | None (TBC) |
| **Charges** | S$0.50 – S$12.00. (1 NZD = 1 SGD) |
| **Financials** | TBC |
| **Impact** | The LTA reported that average road speeds increased by about 20%, while traffic has gone down by about 13% during ERP operational hours, with vehicle numbers dropping from 270,000 to 235,000. Car-pooling has increased, while the hours of peak vehicular traffic have also gradually eased and spread into off-peak hours, despite rising traffic volumes. |

*Source: Review of international pricing initiatives, previous reports and technologies for demand management purposes, D'Artagnan Consulting (2017)*

## FIGURE 27: SINGAPORE ERP MAP




*Source: Review of international pricing initiatives, previous reports and technologies for demand management purposes, D'Artagnan Consulting (2017)*

## 5.4 Case study: London

London was the first major European city to introduce congestion pricing in 2003. The London area scheme is conceptually simple, and reductions in traffic were significant inside and approaching the charged area in the initial years following the scheme's introduction. The scheme also improved bus system capacity and performance, reduced crashes and improved air quality.

Over time, the initial improvements have been eroded by reallocation of road space, road works, and the growth in traffic not sensitive to charge prices (either because it is exempt, such as private hire vehicles[24], or because it has low elasticity of demand, such as local delivery traffic, due to the growth in e-commerce). A 2017 report[25] indicated the scheme is no longer fit for purpose and there are moves to consider options to replace the scheme in the longer term with some form of network pricing across Greater London. In the interim, the focus of the current mayor has been on emissions-based charging to improve local air quality[26]. One step that London has recently taken to improve the longevity of its scheme is removing the exemptions for private hire vehicles. Since April 2019, these vehicles are now required to pay the daily congestion charge; London black cabs have retained their exemption[27]. The scheme is summarised in Table 10 and Figure 28.

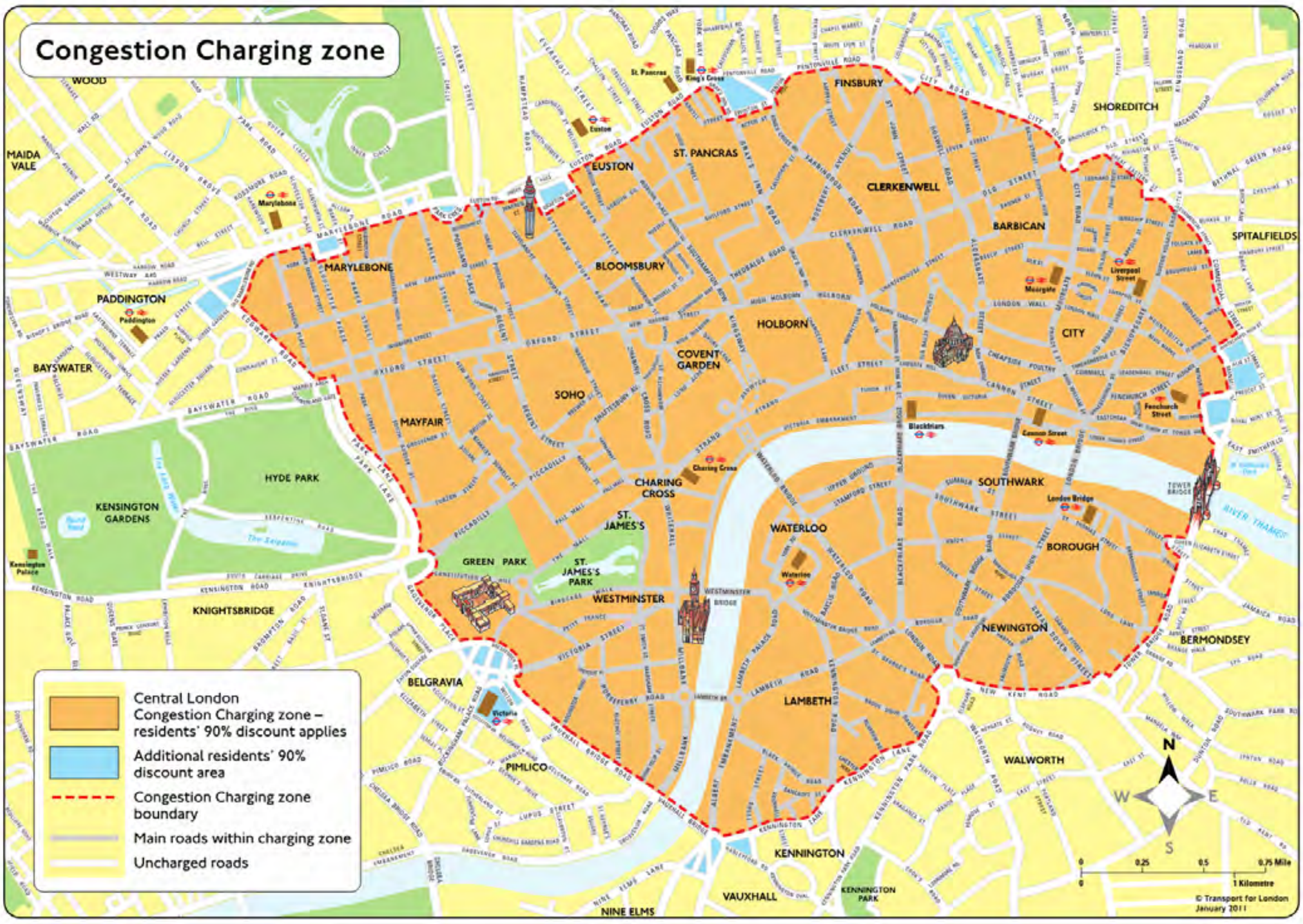
### TABLE 10: LONDON CONGESTION CHARGE SUMMARY

| London Congestion Charge | |
|---|---|
| **Year** | 2003 |
| **Authority** | Transport for London (TfL) |
| **Scheme** | Area wide congestion scheme levies fixed fee on vehicles within Congestion Charge Zone (CCZ) |
| **Description** | Population: 9m; Toll Zone: 30km$^2$; 1.5% of population live within Toll Zone; 68% PT, cycle and walk mode share |
| **Objectives** | Reduce high traffic flow in central London area and raise investment funds for London's transport system. |
| **Implementation** | Mayor Ken Livingstone introduced the London congestion scheme under the powers created by the Greater London Authority Act 1999. The scheme was part of a series of measures to improve the London transport system and included public transport improvements and increased enforcement of parking and traffic regulations. |
| **Technology** | Enforcement is primarily based on ANPR, and the scheme has been operated by IBM since 1 November 2009. |
| **Vehicles** | All cars and freight vehicles |
| **Tariff** | Cordon entry by time of day per vehicle between 07:00 and 18:00 Mondays to Fridays with unlimited travel within the CCZ |
| **Payment** | Payment is online up to 90 days in advance, on the day of travel or by midnight the next charging day. Payment can also be made by telephone and text message once registered online. Discounts are provided if registered with Autopay, an automated payment system which records the number of charging days a vehicle travels within the charging zone each month and bills the customer debit or credit card each month. |
| **Link with Tax** | None |
| **Exemptions** | The system gives 100% discounts to registered cars which emit 75g/km or less of carbon dioxide and meet the Euro 5 standard, vehicles with 9 or more seats, motor-tricycles, two-wheeled motorbikes (and sidecars), mopeds, and roadside recovery vehicles. Residents living within or very close to the zone are eligible for a 90% discount. |
| **Charges** | Standard fee is £11.50 per day if paid by midnight on the day of travel, £14 if paid by the end of the following day, or £10.50 if registered for Autopay. Penalty of between £65 and £195 levied for non-payment. (1 NZD = 0.5 GBP) |
| **Financials** | During the first ten years gross revenue reached £2.6 billion and costs were £1.4 billion (54% of revenue). From 2003 to 2013, about £1.2 billion (46%) of net revenue has been invested in public transport, road and bridge improvements and walking and cycling schemes. Of this, a total of £960 million was invested on the bus network. |
| **Impact** | In 2013 TfL reported that the congestion charging scheme resulted in a 10% reduction in traffic volumes from baseline conditions, and an overall reduction of 11% in vehicle kms in London between 2000 and 2012. However traffic speeds have also been getting progressively slower over the past decade, most likely due to interventions that have reduced the effective capacity of the road network in order to improve the urban environment, increase road safety and prioritise public transport, pedestrian and cycle traffic. |

*Source: Review of international pricing initiatives, previous reports and technologies for demand management purposes, D'Artagnan Consulting (2017)*

24 https://tfl.gov.uk/modes/taxis-and-minicabs/what-to-expect-from-your-journey#on-this-page-0
25 London Stalling – Reducing traffic congestion in London, London Assembly (2017) https://www.london.gov.uk/sites/default/files/london_stalling_-_reducing_traffic_congestion_in_london.pdf
26 https://tfl.gov.uk/modes/driving/ultra-low-emission-zone
27 https://tfl.gov.uk/info-for/taxis-and-private-hire/phvs-and-the-congestion-charge

## FIGURE 28: LONDON CONGESTION CHARGING ZONE MAP




*Source: Review of international pricing initiatives, previous reports and technologies for demand management purposes, D'Artagnan Consulting (2017)*

## 5.6 Case study: Dubai

Dubai's congestion pricing scheme (Salik) was introduced to manage traffic on the main highways through Dubai but has been widely criticised for largely diverting traffic onto parallel routes. It is the only overseas example of congestion pricing that only applies to major highways in a city. The scheme is summarised in Table 11 and Figure 29.

### TABLE 11: DUBAI'S SALIK ROAD PRICING SUMMARY

| Dubai Congestion Charge | |
|---|---|
| **Year** | 2007 |
| **Authority** | Dubai Road and Transport Authority (RTA) |
| **Scheme** | Salik- strategic highways charge |
| **Description** | Population: 3.1m |
| **Objectives** | Designed to capture congestion on major routes and is the only example of congestion pricing that only applies to major highways in a city. |
| **Implementation** | The technology requires large gantry infrastructure and is confined to six charging points. |
| **Technology** | DSRC tags |
| **Vehicles** | All vehicles except buses. |
| **Tariff** | All charging points have same tariff, but hours of operation depends on charging point, ranging from 24 hours to 0900-2200 |
| **Payment** | Post-payment by invoice |
| **Link with Tax** | None, but metro and tram network have been extensively expanded since Salik was introduced, which has helped improve acceptability. |
| **Exemptions** | Military, emergency vehicles, buses or vehicles with disabled owners. |
| **Charges** | NZ$1.50 per charge point |
| **Financials** | General government revenue |
| **Impact** | Dubai RTA reported 25% reduction of traffic at one of the first charging points, with a 50% reduction in travel time, but no statistics are provided for the increases in traffic and travel times on parallel routes. 70% of users polled were critical of the scheme following significant increases in congestion on alternatives routes, and 46% thought traffic had worsened since Salik had been introduced. The conclusion is that although Salik has had some effect, applying charges to main highways only can cause significant diversion of traffic onto parallel routes and undermine the public's belief in the effectiveness of the scheme. |

*Source: Review of international pricing initiatives, previous reports and technologies for demand management purposes, D'Artagnan Consulting (2017)*

### FIGURE 29: DUBAI'S SALIK ROAD PRICING SCHEME MAP


*Source: Review of international pricing initiatives, previous reports and technologies for demand management purposes, D'Artagnan Consulting (2017)*

## 5.7 Case Study: United States High-Occupancy Toll (HOT)/ Express lanes

HOT lanes can be constructed as part of a highway extension but are usually created by converting under-utilised High Occupancy Vehicle (HOV) lanes. HOT lanes have been most widely implemented in the United States and are occasionally considered in the context of congestion pricing. The major distinction is that HOT lanes are adopted as a strategy to leverage existing lanes that have restricted access (ie vehicle must have high occupancy) to provide an improved level of service on poorly performing highways for those willing to pay a toll. As such, pricing is intended to guarantee travel speed, not manage demand on the facility or broader network, but this may be seen as an attractive interim option to offer a priority option instead of pricing all lanes. Nevertheless, the process of converting under-utilised HOV lanes to priced lanes carries with it political and public opinion challenges not dissimilar to broader network charging and demand management schemes. Technically it is difficult to implement such lanes unless there is poorly utilised spare capacity on existing lanes (eg bus or T3 lanes (transit lanes for three or more people)) on motorways. Otherwise new lanes would need to be built, which may be at considerable cost. Typically, such express lanes have been feasible in the US only on long stretches of motorway, with significant distances between on and off ramps, to avoid the congestion, safety and enforcement challenges of motorists weaving excessively in and out of such lanes. HOT lane schemes in the US are summarised in Table 12.

**TABLE 12: UNITED STATES HOT LANE SCHEMES**

| United States HOT Lanes | |
|---|---|
| **Year** | From 1995 |
| **Authority** | Various U.S. road agencies |
| **Description** | HOT lanes, defined as high-occupancy toll lanes, are usually free to high occupancy vehicles (HOVs) but can be used by single-occupancy vehicles for a fee, which can vary by time and traffic flow. |
| **Objectives** | Proponents for HOT lanes argue that they accomplish several objectives by:<br>- filling up underutilised carpool lanes they keep HOV lanes at their optimum utilisation<br>- diverting some drivers from the adjoining general-purpose lanes to reduce congestion in those lanes<br>- provide a premium travel option to drivers for faster trip times and who are willing to pay for the privilege<br>- provide an opportunity for the private sector to fund highway capacity in return for the opportunity to collect tolls. |
| **Implementation** | HOT lanes can be constructed as part of a highway extension but they are usually created by converting underutilised HOV lanes. There are around 20 HOT lane projects in operation throughout the U.S. covering some 400 miles. |
| **Technology** | Windscreen mounted toll tag. Enforcement is primarily based on ANPR supplemented by roadside checks. |
| **Vehicles** | All cars and freight vehicles |
| **Tariff** | By the time of day and variable pricing used based on demand and capacity of the lane to provide a reliable trip time. |
| **Payment** | Terms dependent on the local toll operator |
| **Link with Tax** | None |
| **Exemptions** | HOV are exempt |
| **Charges** | 25 cents to $14 by sector (1 NZD = .73 USD) |
| **Financials** | The Government Accountability Office (GAO) reported the U.S. congestion pricing projects generally have not had excess revenues, and many were not covering the project's operational costs and therefore were not making a contribution to capital or PT costs. This raises the possibility that HOT lane users were being subsidised by other persons who may not use or benefit from the lane. |
| **Revenues** | Pricing implemented to manage congestion, and raise revenue for new projects and in some case PT services. |
| **Impact** | In 2012 the GAO completed an audit of 14 highways pricing projects and found HOT lanes can reduce congestion by improving travel time and speed for HOT lane users, and in some cases increased overall vehicle throughput in certain corridors. However, GAO had some reservations that not all possible relevant effects had been properly assessed, including an inability to isolate the cause of traffic reduction, a decrease in passengers per car in certain corridors, potentially negative impacts on lower-income drivers, and that HOT lanes do not seem to create a rise in PT use. |

*Source: Review of international pricing initiatives, previous reports and technologies for demand management purposes, D'Artagnan Consulting (2017)*

## 5.8 Other congestion pricing schemes

Only a handful of overseas cities have developed and implemented successful road pricing schemes. There have also been a number of failed proposals for congestion pricing schemes, including in the cities of Edinburgh and Manchester. These two UK proposals were rejected by public referendums on the basis that social issues had not been adequately addressed and concerns that scheme designs would have adverse community impacts and generate few benefits, particularly for those that were expected to pay.

Failed schemes offer important lessons on public engagement. Muddled or inaccurate communications often preceded growth in negative public reactions. Manchester and Edinburgh sought only minimal public feedback on design elements. Manchester, moreover, provided inconsistent messaging and imprecise communications on the timing and location of proposed charges. A failed proposal in the Netherlands, by contrast, sought too much public feedback, as the programme morphed from its focus on congestion into a complete reform of the national road charging system. Project sponsors then lost control of messaging about the scheme's purpose.

New York has recently voted to become the first American city to introduce congestion pricing[28]. New York will implement a cordon scheme, with fees to be imposed on vehicles that enter lower Manhattan below 60th Street from elsewhere in the city. Drivers who live in the congestion zone would not pay when they drive within the zone or when they leave the zone, but they would pay when they return from outside the zone.

State legislators are considering several possible exemptions for drivers who are low income, have disabilities or are going to medical appointments. The scheme is not expected to start until 2021 and fees are yet to be decided. The objective is to improve network performance and raise US$1 billion annually, which would then be used to secure bonds totalling US$15 billion for repairs and improvements to public transport.

28 https://www.nytimes.com/2019/03/26/nyregion/what-is-congestion-pricing.html?smprod=nytcore-ipad&smid=nytcore-ipad-share

# 6 CONGESTION PRICING POLICY

When designing a congestion pricing scheme, the pricing policy that is adopted is a key component because it determines the pricing structure that motorists face and consequently the resulting network, spatial, social, and environmental impacts. This section, drawing on the international review, seeks to outline the main considerations that would underpin a practical, effective and fair congestion pricing policy[29].

## 6.1 Policy principles

The development of a congestion pricing policy will inevitably require trade-offs and judgements, similar in kind to that faced by all complex public policy exercises. To assist policymakers in making those decisions, a set of principles (or objectives) were developed by the project, to guide the development of a workable congestion pricing scheme in Auckland. Specifically, those principles are that the scheme should:

1. be effective in terms of generating sustainable improvements in network performance.
2. be flexible to achieve target levels of service by time and location
3. target travel in congested conditions.
4. target travellers with potential alternatives and discourage lower value discretionary trips
5. support functionality to ensure tariffs (prices) can be regularly reviewed to continue to generate target levels of service
6. vary for different vehicle classes according to the contribution they make to congestion
7. be technologically achievable, cost effective, practical and efficient
8. be understandable and avoid undue complexity
9. have minimum exemptions and discounts to avoid undermining the efficacy of the scheme
10. support ability to spatially extend and modify the scheme
11. support the requirement to promote fairness and minimise adverse social impacts
12. support liveable communities and improve urban, environmental and safety outcomes.

## 6.2 Charging options

### 6.2.1 Point-based charges

All the overseas cordon-based congestion pricing schemes that were reviewed, levy point-based charges for vehicles detected crossing a boundary in both inward and outward directions. The Singapore ERP, which is a combined cordon/corridor scheme, also employs a point-based charge. Point-based charges have the following features:

- Charges are cumulative (although there may be a cap on the total charged per day).
- Charges can vary by time and location.

### 6.2.2 Access-based charges

An access-based charge is a variation on a point-based charge, where every vehicle faces the same charge regardless of the location of the chargeable event. An access charge is typically linked with the implementation of an area-based congestion pricing scheme, but in theory it could also be compatible with a cordon or corridor-based scheme. Internationally, London is the only the jurisdiction that has implemented a flat access charge to support its area-based charging scheme. Access charges have the following features:

- Charges do not vary by location.
- Charges can vary by time.
- Charges are not cumulative, no matter how many times a vehicle is detected by the roadside infrastructure within a given defined time window.

29 Tariff Policy Considerations, TCQ Working Paper (2018)

### 6.2.3 Distance-based charges

Distance- or kilometre-based charging seeks to link the consumption of road space with a charge that varies by distance travelled by a vehicle. No jurisdiction has implemented kilometre-based congestion charges, but in theory, distance-based charges could also vary by time and location. Distance-based charging needs to be supported by the installation of in-vehicle hardware supplemented by an ANPR enforcement regime. The on-board units (OBUs) determine a vehicle's location based on receiving satellite signals, and record time and position data, which is then processed into trip data and transmitted via wireless communications to a central server for matching to a schedule for charge generation based on prices that may vary by route.

## 6.3 Other charging parameters

### 6.3.1 Administration versus rules-based

The international review found that most pricing schemes do not adjust prices regularly using an administrative process, which reflects several factors including revenue, network performance, affordability and political considerations. London has increased prices four times over 14 years and Stockholm only once in 10 years. The fact that charging levels change so infrequently makes these schemes easy to understand.

However, the disadvantage with an administrative approach and infrequent price changes is that it may erode the link between the congestion charges and the goal of improving network performance. This is particularly important if service levels deteriorate in the face of increasing traffic volumes, as has happened in recent years in London. In Stockholm, recent price increases, reflecting (in part) a motivation to increase scheme revenues, had the effect of undermining public support. In contrast, the initial Stockholm tariffs were set to improve network performance by reference to extensive traffic modelling.

The only jurisdiction to adopt a strict rules-based approach to setting charge levels is Singapore, which reviews and adjusts prices for individual links every three months to ensure speeds on the routes that are charged are managed within a range of 45-65 km per hour for expressways and 20-30 km per hour for local streets (based on an 85th percentile of speeds sampled). If speeds are too low at specified charging points (prices vary by charging point and direction of travel), prices will be raised at the times of congestion. If speeds are above the target, it is assumed that the ERP is suppressing traffic demand excessively (with inefficient impacts), so prices are incrementally reduced. This helps ensure that charge rates are not too high for the travel time savings obtained and that they do not price away economically valuable trips. Overall, the Singapore approach means that a minimum standard of network performance is assured[30].

The Singapore model also helps build public acceptability because those paying the charge receive a target level of service resulting in improved network conditions, and by reducing charges in some circumstances it addresses concerns that the scheme exists primarily to generate revenue.

30 ERP charges at three gantries were removed during the morning peak in response to higher travel speeds. https://sg.news.yahoo.com/erp-charges-three-gantries-removed-peak-morning-hours-125315512.html

### 6.3.2 Time bands

The international review found that most pricing schemes adjust prices according to time bands that range from 30 minutes to five hours. Experience in Singapore, Stockholm and Gothenburg indicates that having a graduated series of steps in charges up to a peak rate (and down again) helps to spread demand. It also helps prevent people speeding to avoid paying a higher charge or waiting at the roadside in order to pay a reduced rate.

Gothenburg reported that the charging scheme has spread demand to a 'fairly even level' during charging hours and Stockholm reported that the different charge levels had a traffic smoothing effect. In contrast, the area scheme in London levies a single charge for an entire day. This removes the incentive to limit driving inside the cordon, because it is the same price for circulating for the entire day as it is for one trip. It also encourages trips to be undertaken immediately before and after the charging period.

### 6.3.3 Direction of travel

Traffic congestion is usually related to the direction of travel, with most cities characterised by congested inbound flows (generally to the city centre) in the morning peak, and outbound flows in the afternoon peak. It is therefore sensible to consider adding the direction of travel as a metric to assist in tariff setting. In this context, trips in the congested direction are discouraged through higher charges while those travelling in the uncongested direction should enjoy a lower (or zero) tariff.

In Singapore, charging rates (set by the required levels of service) vary by the direction of travel in addition to the use of time bands. When considered alongside its other features, the Singapore ERP is now widely seen as the most sophisticated and effective road pricing solution, as each charging point has its own price schedule based on time of day, direction of travel and even day of the week (some points operate on Saturdays).

### 6.3.4 Charging caps

Daily maximum charges help to mitigate excessive negative financial impacts for travellers who have a limited ability to switch modes, change departure times or defer their travel. Daily caps may also be a sensible response for commercial vehicles such as couriers, which are required to undertake numerous trips as part of their business activities. Like discounts and exemptions, discussed below, daily caps add administrative and technological complexity in reliably identifying eligible accounts and ensuring details are accurate if circumstances change.

In the case of the Stockholm and Gothenburg congestion pricing schemes, mitigations are applied through a policy of daily maximum charges per vehicle. In Stockholm the daily charging cap is set at SEK 105 (NZD 17) representing approximately three peak-period trips depending on the exact time of travel, noting that the scheme operates between 06:30 and 18:30 on weekdays.

In contrast, Singapore does not apply daily caps for private or commercial vehicles, noting that this would be difficult to achieve because the ERP system is based on pre-paid accounts, with charges deducted each time a vehicle is detected by a charging point.

### 6.3.5 Vehicle classes

The international review undertaken by TCQ found that congestion charges in Stockholm, Gothenburg and London do not vary according to vehicle class, but Singapore has a differentiated charging structure based on passenger car unit (PCU) equivalents as follows:

1. Cars, taxis and light goods vehicles are 1 PCU.
2. Motorcycles are 0.5 PCU; heavy goods vehicles and small buses are 1.5 PCU.
3. Very heavy goods vehicles and big buses are 2 PCU.

There are legitimate grounds for why a vehicle-type adjustment should be used. It helps capture the differences in consumption of road space and operating characteristics, such as acceleration/deceleration, of different vehicles, both of which are factors in a vehicle's contribution to congestion.

### 6.3.6 Exemptions and discounts

Emergency vehicles are universally exempt, and buses are exempt in all schemes, except Singapore, because there is no demand response expected from them. London has a significant number of discounts and exemptions, including resident concessions and taxis (when actively licensed with London Taxi and Private Hire). Due to the relatively high proportion of taxis in the charging zone (along with buses and cars of residents living within the charging zone), this means that approximately half of traffic circulating in central London does not pay the congestion charge. The approach adopted by London has dramatically undermined the effectiveness of the scheme in managing congestion[31]. It will be important to apply discounts and exemptions for select purposes to maintain scheme effectiveness and credibility with those who will pay[32].

Discounts and exemptions can be used to mitigate excessively negative impacts on road users who are not the target of a congestion pricing scheme (eg drivers with mobility impairments). However, discounts and exemptions add costs to any scheme, as they add administrative and technical complexity in reliably identifying eligible vehicles and ensuring details are updated for such vehicles if circumstances change. Measures need to be taken to minimise fraudulent applications for discounts and exemptions. Discounts and exemptions will also reduce scheme revenue, although maximisation of revenue is not an objective for TCQ.

31 Noting that London has recently reduced the number of exemptions, with private hire vehicles (eg mini-cabs and Uber, Lyft, etc) required to pay the congestion charge from April 2019.
32 Review of international pricing initiatives, previous reports and technologies for demand management purposes, D'Artagnan Consulting (2017)

# 7 COMMUNITY CONSIDERATIONS

This section discusses congestion pricing from the perspective of the community. TCQ's Terms of Reference state that, as part of achieving the overall objective of improving the performance of Auckland's transport network, consideration must be given to wider economic and social effects, including a scheme's potential impact on Māori.

A comprehensive understanding of potential community impacts is a key consideration for developing a congestion pricing scheme for Auckland because a lack of public acceptance is the single biggest factor that has halted development of urban congestion pricing schemes overseas. Poorly designed schemes can disproportionately affect those least able to pay and can generate adverse social impacts. It is also important that a potential scheme will generate benefits for communities, including for the motorists required to pay the congestion charge.

## 7.1 Main terms

### 7.1.1 Benefits and costs

To assist policymakers to understand how congestion pricing can impact different household, business and spatial groups, it is important to account for both monetary and non-monetary costs and benefits. Potential impacts comprise six interacting elements [33,34]:

1. The congestion charges paid
2. Compliance costs for those paying charges
3. The cost of adapting travel patterns to the charges
4. The value from travel time gains and improved trip reliability
5. The value from improved accessibility to employment, education, social and recreation activities
6. The benefits from the use of any net charging revenues.

### 7.1.2 Fairness and equity

Fairness and equity consider the relative distribution of benefits and costs between individuals and social groups, whereas efficiency describes the total societal returns from an intervention. People have different ideas about what is an equitable distribution of costs and benefits, or what is 'fair'. Understanding these different positions can help in communicating the impacts of congestion pricing and help decision-makers to judge whether congestion pricing is likely to be publicly acceptable.

Fairness in the context of congestion pricing has a number of dimensions:

- Vertical equity – how benefits and costs are distributed across income groups.
- Horizontal equity – how benefits and costs are distributed across similar groups of users, households, businesses and communities.
- Spatial equity – how benefits and costs for households and businesses are distributed across geographical areas.

Because most households and individuals will incur a mix of costs and benefits, and are likely to fall into multiple categories, complex measures are needed to capture different categories of impacts. The task is further complicated by the fact that congestion pricing will have both financial and non-financial impacts on individuals, households and businesses.

33 Review of international pricing initiatives, previous reports and technologies for demand management purposes, D'Artagnan Consulting (2017)
34 Social and Distributional Impacts of Time and Space-based Road Pricing (final draft report), MRCagney (2018)

## 7.2 Social impact studies

### 7.2.1 Community impacts

Although road users tend to support congestion pricing after it is introduced, congestion pricing is controversial because, on introduction, depending on scheme design, it is likely that some existing road users experience benefits while others are disadvantaged. Drivers who put a high value on time gain from better journeys; this typically includes much commercial traffic, which places a high value on time and will experience reduced operating costs through smoother journeys. Drivers who put a low value on time and have a low capacity to pay, lose by being obliged to change departure times, switch to a less convenient mode, or pay a charge that exceeds the value of the time savings gained. Congestion pricing is also controversial because the revenues raised may be larger than the direct benefits to drivers; the biggest benefits fall to the community more widely, including public transport users (who obtain travel time savings without paying the charge) and business-related travellers (who place a high value on time).

The potential community impacts generated by a congestion pricing scheme are primarily derived from changing existing travel patterns, with the direction and size of the impact dependent upon:

- the design of the charging scheme, such as whether it is a cordon charge, area charge, corridor charge, or another type
- the structure of the charge (location, direction of travel and variation of time)
- the location and coverage of the charging scheme
- the availability and quality of non-car transport choices
- the availability and quality of alternative routes
- the location of high, medium and low-income households and other household types (including at-risk groups), and the types of trips that they make at the times charging may operate
- how revenues are spent or redistributed.

### 7.2.2 International evidence[35,36]

In December 2017, the International Transport Forum (ITF) held a roundtable meeting in Auckland that brought together around 20 experts from eight countries to discuss the theory and practice of assessing social impacts of road pricing. The roundtable considered commissioned papers on the relationship of road pricing to peak demand pricing on public transport, how a better allocation of road space can improve social welfare, and an assessment of two road pricing schemes in Sweden. Discussions also covered the road pricing scheme and experience in Singapore, as well as presentations on the importance of detailed modelling in social assessment studies.

The ITF expert group concluded that the overall distributional impacts of road pricing are generally modest (as expected from an assessment of net overall benefits and costs). However, pricing schemes can clearly have a large impact on some vulnerable households and individuals (as revealed through a social assessment). This is highly dependent on the specific design of the scheme and, in particular, the location of charging points.

Assessing the social impacts of road pricing requires examination of the financial burden on households by income group and other characteristics. A number of the studies reported by the ITF looked at the level of vulnerability by location based on a mix of income, cost burden, adaptive capacity and access to jobs. Results confirm that, while the overall distributional impacts of road pricing are likely to be small, there can be households in pockets of urban areas that are seriously adversely affected. Disaggregated spatial analysis (using data on demographics, trip patterns and transport accessibility among others) can also be used to design road pricing schemes to reduce the number of vulnerable households affected and indicate where investments in public transport can most effectively provide an alternative to use of the car.

The ITF expert group found that congestion pricing should ideally be implemented with careful differentiation of charges by location and time. The less sophisticated the pricing scheme, the more adverse impacts result because users are not priced strictly according to use (or benefit obtained). To illustrate, cordon charging can have a disproportionate impact on short trips and its impact can be high for vulnerable users who reside just outside a cordon boundary but need to commute by car to the cordoned area.

Area-wide corridor charging, as developed in Singapore, reduces boundary effects and is more effective in reducing traffic within the overall charging zone. The size of distributive effects, however, will depend on traffic patterns by income group and the location of jobs and residential zones. Fine differentiation of pricing by time of use allows travellers to select their preferred departure time to match their willingness to pay. This enables most users to adjust travel patterns rather than be priced off the road, reducing negative distributional impacts.

Targeted assistance can be used to support incomes or compensate travel costs for those on the lowest incomes. An example of an application to protect the mobility of the poor, while not in relation to congestion pricing, is the use of targeted subsidies to low income households provided through electronic travel cards.

Care needs to be taken to ensure any approaches to target assistance minimise opportunities for fraud. In addition, exemptions and discounts have been used to improve the acceptance of road pricing schemes and target assistance to user groups but can jeopardise the effectiveness of a scheme in managing congestion. This has been the case with the London Congestion Charge, discussed previously in Section 6.3.6.

35 Social Impacts of Time and Space-based Road Pricing, International Transport Forum (2018) https://www.itf-oecd.org/sites/default/files/docs/social-impacts-road-pricing.pdf

36 See also Social and Distributional Impacts of Time and Space-based Road Pricing (final draft report), MRCagney (2018) for a review of a selection of published papers on the equity impacts of road pricing. The paper concludes that the distributional effects of road pricing are complex and context dependent.

### 7.2.3 Auckland social impact studies

There have been three previous studies looking to evaluate the equity impacts of potential road pricing schemes in Auckland:

1. 2006 Auckland Road Pricing Evaluation Study (ARPES)[37]
2. 2008 Auckland Road Pricing Study (ARPS)[38]
3. 2014 Funding Auckland's Transport Future (FATF).

The share of households affected, and the magnitude of impacts, varies significantly across the schemes considered by the three previous Auckland studies. All the exercises found that area and larger cordon-based charges affect the greatest share of households, and that different types of households will be affected by different charging schemes.

Market Economics, in a study undertaken as part of the FATF project, conducted an analysis of vulnerable households, which it defined as low income households (bottom 20% of income within each category) with or without children[39]. These households were found to pay less for transport than the average Auckland household in dollar terms, but they experience very high impacts relative to incomes.

Market Economics' quantitative analysis was supported by qualitative research undertaken by Gravitas into vulnerable households, which found that these households would not be able to absorb congestion charges and, as a result, would have to make changes to lifestyle or travel patterns to mitigate costs.

## 7.3 Use of revenues

Congestion pricing is by its nature a revenue source, as congestion pricing works by exposing road users to a price to achieve behaviour change to reduce the external costs of congestion to society. Overseas, a range of approaches has been adopted for the use of congestion pricing revenues. Any of these could be adopted for Auckland. Transparency in the use of revenue generated and the hypothecation of congestion pricing scheme revenues for urban transport projects and services has been shown to be an important factor in helping to overcome community resistance[40].

Factoring in use of revenues is important to understanding the community impacts of a potential congestion pricing scheme in Auckland[41]. Revenue could be used to address community impacts as follows[42]:

- Reinvest in public transport or other alternatives to provide more people with a viable alternative mode choice in lieu of paying the charge, helping to reduce the financial impact on them (this was a recommendation from the ITF[43] roundtable report for cities with insufficient public transport provision).
- Redistribute in the form of reductions to taxes which may or may not be related to vehicle ownership and usage (such as income, fuel, motor vehicle registration or property rates) – this could be used to counterbalance any negative distributional impacts from congestion pricing.
- Target redistributions to those identified as being negatively affected by the scheme, which could involve payments or reimbursements to those on low incomes who incur the charge.

37 https://www.transport.govt.nz/land/auckland/the-congestion-question/previous-ministry-of-transport-studies/
38 https://www.transport.govt.nz/land/auckland/the-congestion-question/previous-ministry-of-transport-studies/
39 Analysis of the affordability and social impacts of alternative transport funding mechanisms on Auckland households, Market Economics (2014)
40 Review of international pricing initiatives, previous reports and technologies for demand management purposes, D'Artagnan Consulting (2017)
41 Is Congestion Pricing Fair? Consumer and Citizen Perspectives on Equity Effects, Jonas Eliasson, KTH Royal Institute of Technology, CTS Working Paper (2016)
42 Treatment of Revenue, TCQ Working Paper (2018)
43 Social Impacts of Time and Space-based Road Pricing, International Transport Forum (2018)

# 8 TECHNOLOGY OPTIONS

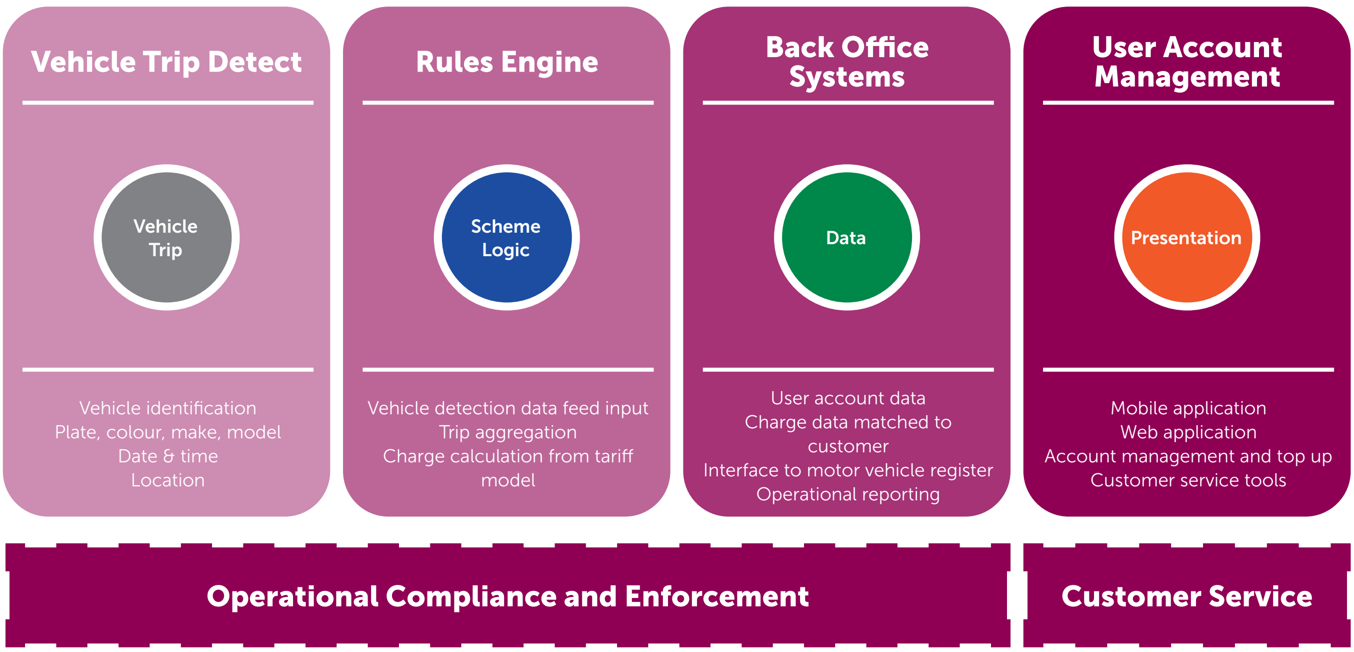
This section provides a review of technology options currently available for congestion pricing as well as technologies that might be available in the future. The key functional elements and potential technology options that underpin a congestion pricing scheme are described and evaluated. The analysis builds on the international review and also considers the Auckland context.

## 8.1 Key functional elements

A congestion pricing system comprises four key technology areas and two operational functions (shown in Figure 30), which together can deliver a successful charging scheme.

1. Vehicle trip detection encompasses the technology that is used to identify all vehicle trips passing a charging point.
2. The charging scheme rules engine is the implementation of a logical set of rules that processes high volume vehicle trip data and applies the scheme tariff model to allocate and aggregate appropriate vehicle trip charges.
3. The back-office systems include all the data collection, aggregation, administration and operational reporting functions of the scheme.
4. User account management includes the customer service functions to establish, change and manage accounts, pay charges and manage queries.

**FIGURE 30: HIGH LEVEL TECHNICAL OVERVIEW OF A CONGESTION PRICING SYSTEM**




*Source: Technical assessment, TCQ Working Paper (2019)*

## 8.2 Technology for vehicle trip detection and enforcement

To implement an automated congestion pricing scheme, it is necessary to identify vehicles and their location (at charging points). The primary requirement for vehicle detection is that the system is accurate, reliable and not open to manipulation. ANPR using roadside cameras is widely accepted as the standard technology for this purpose and is currently the only viable option for scheme enforcement.

### 8.2.1 Global Navigation Satellite Systems

GNSS work by using in-vehicle devices (or OBUs) to receive satellite signals and convert these into vehicle position and trip data that is then transmitted to a back-office system for processing and billing. GNSS offers the primary advantage of being able to identify, measure and report vehicle trip data even where ANPR infrastructure is not present. GNSS is not tied to roadside infrastructure and so can apply pricing that includes consumption of road use by distance (and/or time) that varies by specific road. This offers unrivalled flexibility in charging scheme design and options. However, ANPR technology is still required for scheme enforcement, to identify vehicles without functioning OBUs, including vehicles from outside the immediate region that may only occasionally enter an area where the charging occurs.

Internationally, no ubiquitous all-vehicle charging scheme exists that utilises GNSS location technology. Whilst technically feasible and thoroughly evaluated in many countries, all designs were discarded for simpler and more cost-effective solutions. Singapore has stated it intends to gradually rollout GNSS capable OBUs from late 2020 to enhance its existing infrastructure-based dedicated short-range communication (DSRC) system[44]. Initially the devices will be used to provide value-added services including real-time traffic information and ticketless parking options, though in time Singapore is considering a move to distance-based charging. It should also be noted that gantries with ANPR and tag readers will still be utilised for vehicle detection, enforcement and charge calculation.

Adding GNSS capability to any congestion pricing scheme brings with it significant additional costs and risks, which would need to be weighed up. Some of these include:

- No suitable light-vehicle OBU is currently available off-the-shelf. One would need to be developed from the ground up, which poses significant research and development cost as well as technical, performance and timing risks.
- OBUs would need to be installed into more than one million vehicles in Auckland, necessitating a major and costly one-off exercise. Further, they would need to be made available for installation into new vehicles entering the market in the future.
- OBU cost is estimated at $180-$250 each. There would also be an approximate cost of $10/month for ongoing cellular and other charges, even if the vehicle is not used. With approximately 1.2 million vehicles registered in Auckland, this would equate to an upfront cost of $216-$300 million for the OBUs and an ongoing cost of $12 million/month (or $144 million/annum) for cellular and other charges.
- Additional back-end server applications, processing and storage would be required to receive the OBU data and correlate this with ANPR data feeds.
- Even infrequent road users (eg out of town visitors) will require an OBU (with a fine for driving at charged times without one) or have to pay by other means, potentially with a higher cost day pass (to discourage those with OBUs from using a day pass as a cheaper option). This runs the risk of penalising infrequent road users with extra costs. Based on observations of the Stockholm scheme, there would also be reasonable numbers of out of town visitors – in the order of 1,000 per day.

44 A wireless communication technology that enables highly secure, high-speed direct communication between vehicles and the surrounding infrastructure, without any cellular infrastructure.
https://www.lta.gov.sg/content/ltagov/en/newsroom/2019/6/3/details-of-new-erp-system-still-being-finalised.html

- Providing the high quality and reliable installation of OBUs into all road users' vehicles would be a considerable challenge. Low quality installations could result in OBU failure, vehicle warranty or reliability issues, and low user satisfaction, whereas professional installation would add cost and time for users.
- Device failure could result from users purposefully or accidentally disabling the OBU and device enforcement would be very difficult and could be seen as overly intrusive as it would require identification of vehicles without functioning OBUs.
- Rolling out mapping, tariff and software updates to all the devices (depending on the OBU design) poses significant timing, transmission and cost challenges when engineering and scheme upgrades take place.

In addition to technical and cost considerations, privacy concerns have also been identified with proposals for GNSS-based congestion pricing systems because of the need to collect vast amounts of vehicle location data, including information for travel that is not subject to charging. Privacy issues have been raised as a specific concern that has contributed to the abandonment of some schemes overseas[45]. In contrast, the public in New Zealand has generally accepted ANPR for use on our existing toll roads, though a formal privacy assessment will be required once a more detailed congestion pricing scheme is developed.

### 8.2.2 Smartphones

Whilst smartphones contain GNSS capability and avoid the need for an in-vehicle OBU, several attempts to use smartphones for road pricing in the USA found serious shortcomings. The main issue is that a smartphone tracks an individual carrying a phone not a vehicle. This means other trips like public transport and bicycle trips run the risk of being charged, or for more than one phone in a vehicle to be tracked for charging purposes. In addition, not all road users will have a smartphone or have one that would be compatible with such an app. Smartphones are, however, desirable as a channel for user account management. Any scheme would benefit from the development of an easy to use and well-designed account management smartphone and/or web application. This app could be extended in the future for voluntary opt-in location-based charging pilots. These pilots could be used to gauge public acceptance and address usability, privacy and technical risks around potential future GNSS charging schemes.

### 8.2.3 ANPR

ANPR works through the use of roadside-mounted cameras that continuously capture images of all passing vehicles. Images of the licence plates are then processed using optical character recognition (OCR) software and converted to machine readable text. This is similar to the technology used by document scanning software to convert document images into text documents.

Initially, ANPR was an integral part of road toll collection using in-vehicle electronic toll tags to capture information to assist with incomplete transactions, non-working tags, and violations by unequipped vehicles. However, as ANPR technology has improved significantly, it has become sufficiently reliable by itself to use for road tolling. There have been three main areas of technology improvements to ANPR:

1. Better image processing techniques (algorithms) to read the number plate and record vehicle characteristics from a given image
2. Increases in memory speed and size, greatly increasing speeds that a digital camera can capture an image
3. Improvement in camera lens quality and subject lighting.

The increases in memory speed and size allow multiple images to be captured and compared, in order to select the 'best' image for interpretation by the processing algorithms. Moreover, fast processing power allows the

45 The UK's National Road Pricing programme (2005–2007) was abandoned, in part, due to concern over privacy.

camera controls to automatically adjust for aperture, light, glare or blooming effects of headlights or reflection for each image. Finally, these systems can now also use other visually captured information, such as the vehicle model and colour, to provide an 'electronic fingerprint', allowing vehicles to be positively identified even when a perfect read of the number plate cannot be made.

The number of cameras needed to cover a given roadway is also decreasing. Modern cameras can now handle the entire video capture and interpretation to read the number plates of two or three vehicles, visible in multiple lanes, simultaneously. An example from London is shown in Figure 31.

**FIGURE 31: LONDON ANPR INSTALLATION**


*Source: Wikipedia Commons*

### 8.2.4 Preferred vehicle detection and enforcement

ANPR offers a robust and effective solution without the need for road users to fit hardware into their vehicles. All necessary vehicle detection and identification can be done remotely, using fixed roadside cameras and existing number plate registration and enforcement systems. Internationally, ANPR is considered the most cost-effective technology to meet desired road pricing objectives. The only occasions where alternative technologies have been considered are in jurisdictions where licence plate quality is low or the quality of data in the motor vehicle register is questionable.

ANPR cameras are required for the enforcement of any congestion scheme, so it is logical to utilise these same cameras and back-end systems for vehicle trip detection and charging. A scheme utilising ANPR reduces development cost and risk considerably, whilst still meeting the objectives of a congestion pricing scheme. An ANPR-based scheme does not preclude the opportunity to expand the system in the future by adding GNSS technology as wider public education and acceptance grows.

The fact that road pricing systems typically need renewal within a seven to ten-year timeframe provides an appropriate opportunity to prove and embed the key elements of a system at relatively low risk, before experimenting with additional technologies in the longer term. This is in line with the approach taken by the Land Transport Authority in Singapore, which has been operating and incrementally modernising its pricing scheme since 1975. Furthermore, as Singapore is intending to transition towards GNSS technology, the lessons from its implementation could help inform future generations of system technology for Auckland and other cities in the coming years.

London, Stockholm and Gothenburg all use ANPR as the sole charging technology – covering vehicle detection and enforcement. In Germany, the latest generation of ANPR cameras are on single vertical towers located on the road verge for enforcement, avoiding the need for costly roadway-wide gantry installations. ANPR is already deployed as the sole detection technology for existing free-flow tolling systems in New Zealand and is working to a high level of accuracy (over 98%).

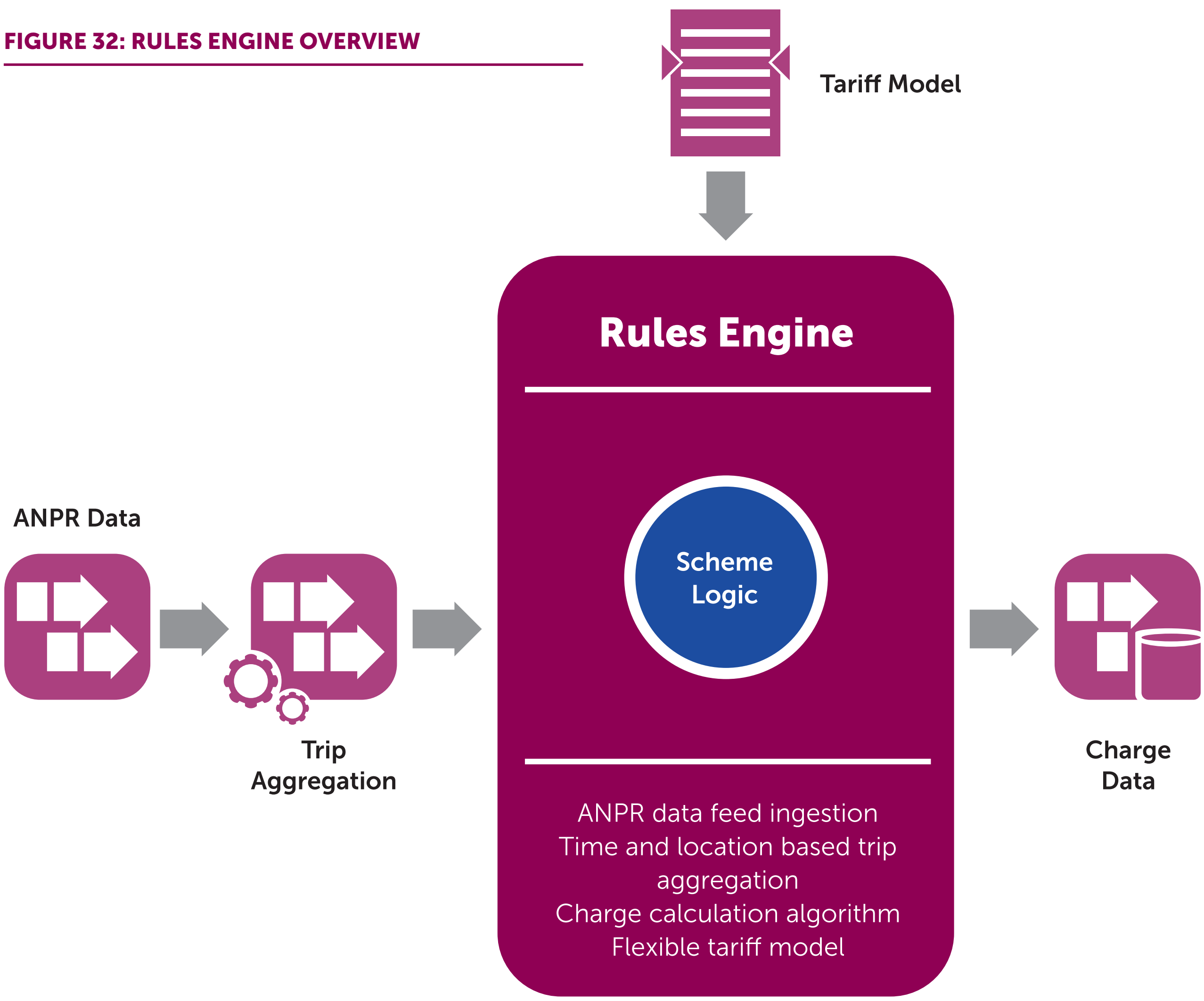
## 8.3 Rules Engine

The Rules Engine is the system that makes the tariff policy operational by processing and aggregating the ANPR data stream and metadata from all the cameras. The Rules Engine algorithm can calculate charges based on the vehicle type, location and time of individual vehicle trips, and will output the charge data assigned to unique vehicles into the back-office system.

The Rules Engine is required to support high volumes of ANPR data as well as be highly scalable to support increases in future traffic volumes and possible scheme expansion. It is envisaged that more than a million potentially chargeable events could be generated per day. At peak times, the system should be able to support the generation of up to 200 chargeable events per second, which could be sourced from 1,000 vehicle detections per second depending on camera redundancy and distribution. It must also be flexible enough to facilitate changes to the tariff model.

A Rules Engine is shown schematically in Figure 32.

**FIGURE 32: RULES ENGINE OVERVIEW**



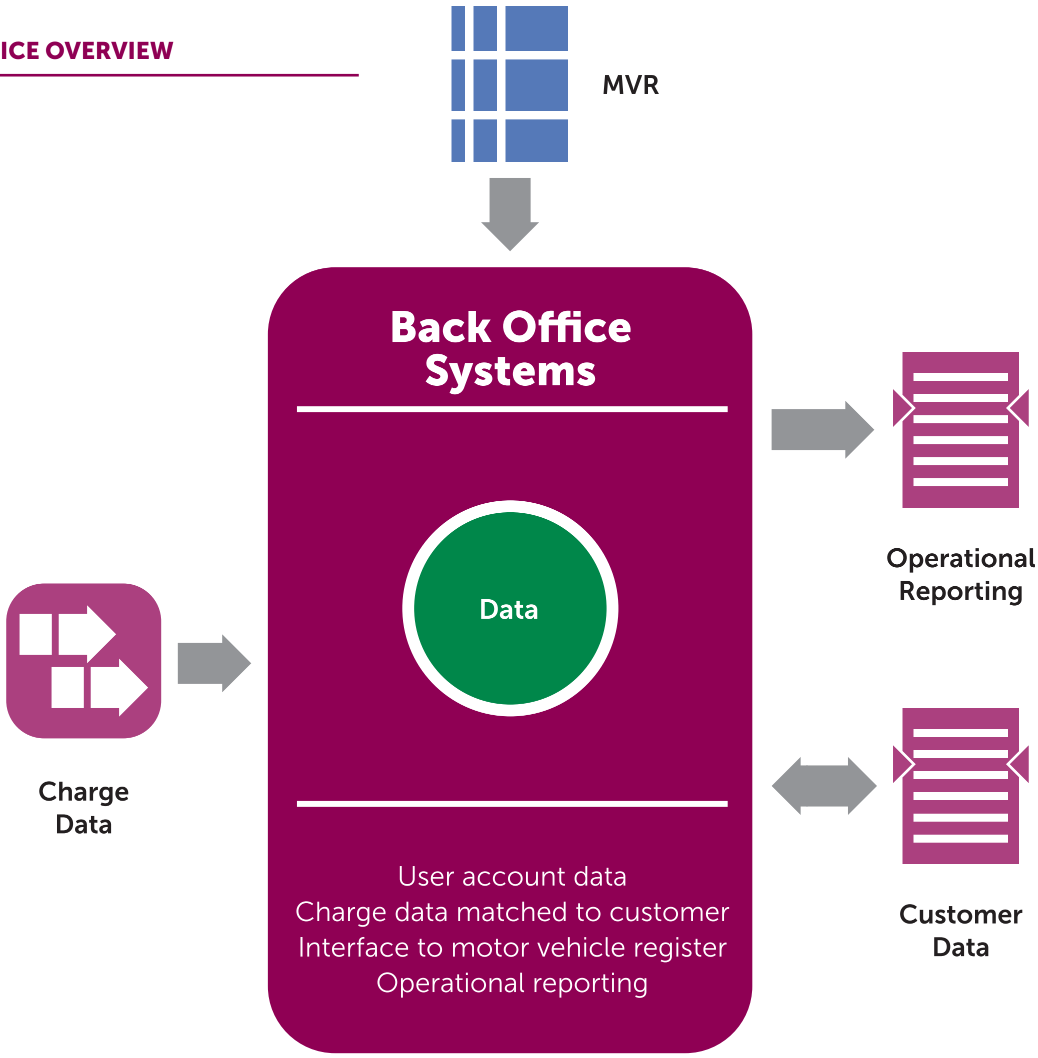

*Source: Technical assessment, TCQ Working Paper (2019)*

## 8.4 Back-office system

The back-office system receives vehicle charge data output from the Rules Engine. This data is then matched to customer accounts where the account balance is updated. Customer data is stored within the back-office and may be updated via the user account management functions. The back-office connects to the motor vehicle register (MVR) via a common data interface so that registered vehicle owners can be automatically updated within user accounts and registered owners can be contacted when vehicles are not found to be within the existing accounts database. Operational reporting is also sent from the back-office to operations teams such as Customer Service, Technical Support, Scheme Monitoring, Collections and Enforcement.

The back-office system is shown schematically in Figure 33.

**FIGURE 33: BACK-OFFICE OVERVIEW**




*Source: Technical assessment, TCQ Working Paper (2019)*

## 8.5 User account management

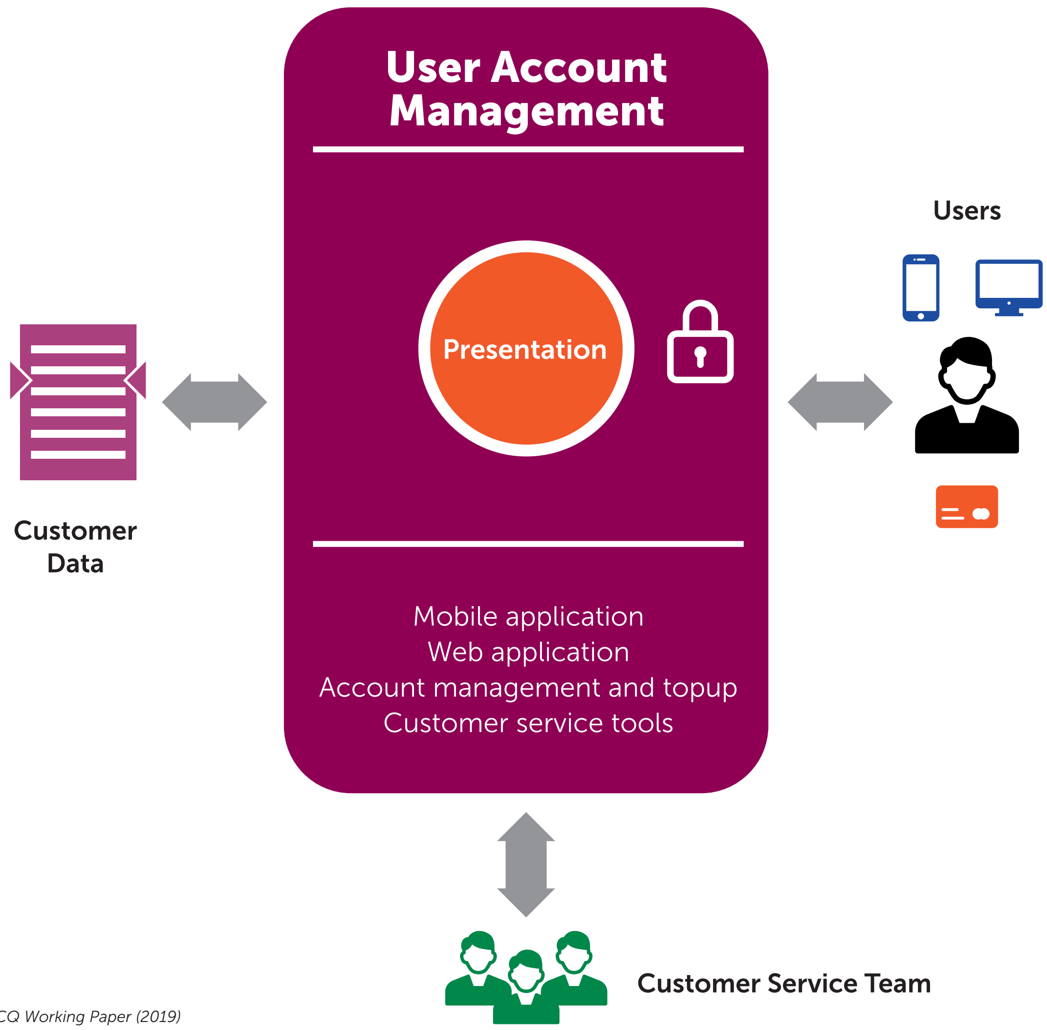
User account management encompasses the presentation of user data and is the place where customers can easily interact with their charge account via their smartphone or computer. For example, Auckland Transport has myAT, where customers can view and edit their AT HOP card account. The user account management system will include a web front-end as well as a mobile app or mobile web application. It is also envisaged that this function will need call-centre capability for users who experience difficulties with the online interface or who are not comfortable with a solely web-based system. User account functions that are likely to be carried out via the application include:

- view current balance
- view trips and payment history
- update profile details and login credentials
- add/remove vehicles
- top-up account and setup automatic payments
- apply for a discount or exemption
- manage customer queries and complaints
- create and delete accounts
- contact customer service.

The Customer Service team will also be able to interact with the user account system to assist with customer enquiries.

An overview of the user account management function is shown in Figure 34.

**FIGURE 34: USER ACCOUNT OVERVIEW**

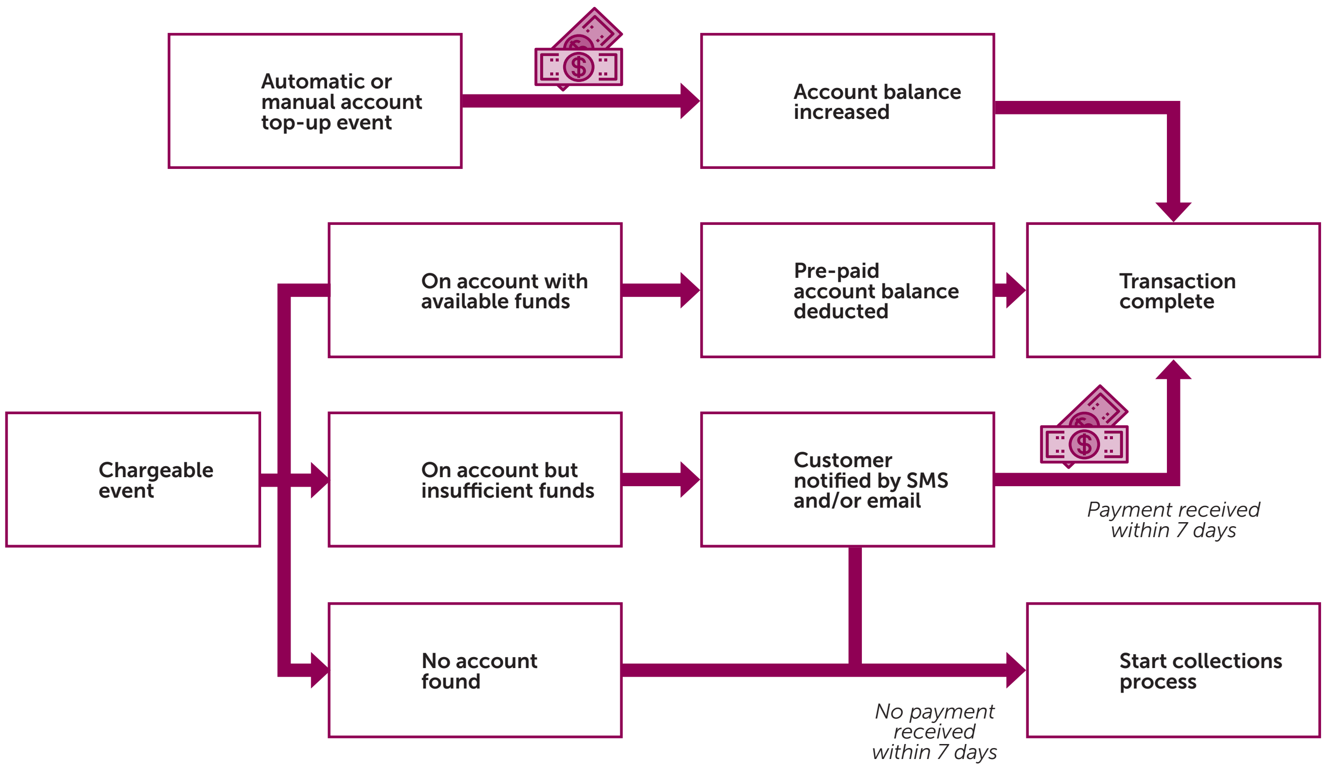



*Source: Technical assessment, TCQ Working Paper (2019)*

## 8.6 Compliance and enforcement

Compliance and enforcement involve the matching of chargeable events against payments received and the collection of payments for unpaid vehicle trips across charging points. Figure 35 illustrates a possible process flow to initiate the collections process if payment for the charge is not received.

**FIGURE 35: ENFORCEMENT TRANSACTION FLOW**




*Source: Technical assessment, TCQ Working Paper (2019)*


Part three

# OPTIONS FOR CONGESTION PRICING IN AUCKLAND

**This section describes the identification and analysis of potential pricing options for traffic demand management purposes in Auckland. The options selection and evaluation process was undertaken in two stages, involving longlist and shortlist options, followed by the development of an illustrative tariff concept suitable for the Auckland environment.**

9. **Options Development:** provides information on the longlist and shortlist options development process.

10. **Shortlist Options Evaluation:** presents the results of the evaluation exercise undertaken for the five shortlist options.

11. **Illustrative Tariff Concept:** develops an illustrative tariff concept for the two congestion pricing schemes identified as having the most potential for Auckland.

# 9 OPTIONS DEVELOPMENT

## 9.1 Longlist of options

A longlist of 26 options was developed that had the potential to reduce congestion, ranging in size, scale and type. The purpose of developing a longlist of options for reducing congestion in Auckland was to ensure the project cast a wide net in terms of the concepts that might be applicable and could be considered. The majority of longlist options included variations of pricing scheme concepts which have been implemented around the world, including area, cordon and corridor schemes of varying size and scale. A number of non-pricing options were also included, acknowledging the potential of alternative transport policies to manage/influence demand, such as changes to vehicle ownership and parking costs and car sharing or public transport fare policies. It was highly unlikely that any of the options generated at the longlist stage would be the exact scheme that might eventually be implemented. The aim was to develop the longlist of options to a sufficient level of detail to enable an evaluation of their comparative performance.

## 9.2 Longlist evaluation

The longlist options were assessed using an evaluation framework that incorporated three categories. These categories considered the potential impact on congestion (network performance), social/equity impacts, and practical considerations around flexibility and feasibility. The categories are listed below with initial weightings shown in brackets. The weightings were developed to reflect TCQ's Terms of Reference, and the ability of the categories to differentiate between longlist options:

1. how effective they would be in reducing congestion (65%)
2. economic, social, environmental and safety considerations (20%)
3. efficiency, flexibility and wider considerations (15%).

The longlist options were each scored against a set of criteria applicable to each of the three high level categories. The scoring was supported by a range of information and data about Auckland's demographics, census data, travel patterns, household income, and lessons from implementing congestion pricing schemes overseas. Table 13 shows each category, criteria and the supporting information that was referenced. The longlist evaluation was based on a qualitative review, and no detailed assessment or financial analysis was undertaken.

**TABLE 13: EVALUATION FRAMEWORK CATEGORIES, CRITERIA AND SUPPORTING INFORMATION**

| Category | Summarised critera | Supporting information |
|---|---|---|
| Network performance | • Travel time and reliability<br>• Unintended consequences (eg diversions)<br>• Impacts on freight routes<br>• Improvement in public transport and active modes | • Auckland's demographics and topography<br>• Origin/destination and travel to work data<br>• Scale and location of projected growth in Auckland |
| Economic, social, environmental and safety considerations | • Public acceptability<br>• Household, business and spatial equity<br>• Emissions and environmental impacts<br>• Safety | • Household income data<br>• Car-free households and access to public transport<br>• Waka Kotahi Economic Evaluation Manual guidance on safety and economic considerations |
| Efficiency, flexibility and wider considerations | • Efficiency<br>• Flexibility<br>• Enforcement<br>• Privacy<br>• Risk<br>• Revenue transparency | • Indicative cost considerations<br>• Overseas experience of pricing and other initiatives |

The summarised set of scores from the longlist evaluation is listed in Table 14.

**TABLE 14: LONGLIST SUMMARY**

| Number | Option name | Rank | Shortlist option |
|---|---|---|---|
| 1 | City centre cordon | 12 | Y |
| 2 | City centre area scheme | 16 | N |
| 3 | Inner urban cordon | 13 | N |
| 4 | Inner urban area | 17 | N |
| 5 | Isthmus cordon | 10 | N |
| 6 | Isthmus area | 7 | Y |
| 7 | Urban cordon | 26 | N |
| 8 | Urban area | 5 | N |
| 9 | Double cordon | 19 | N |
| 10 | Employment centres | 9 | N |
| 11 | Zonal cordon | 8 | N |
| 12 | State highway corridors | 25 | N |
| 13 | Strategic corridors | 3 | Y – merged with option 14 |
| 14 | Target congested corridor | 2 | Y – merged with option 13 |
| 15 | Strategic corridor and city centre area | 4 | Y – combination option |
| 16 | Regional network scheme | 1 | Y – noting technology challenges |
| 17 | Express lanes | 24 | N |
| 18 | Strategic corridor and express lanes | 6 | N |
| 19 | Regional fuel tax (RFT) | 15 | N |
| 20 | Regional registration fee | 23 | N |
| 21 | Parking policy | 20 | N |
| 22 | Car sharing | 11 | N |
| 23 | Mobility rationing | 21 | N |
| 24 | Reverse tolling | 18 | N |
| 25 | Infrastructure pricing | 22 | N |
| 26 | Free public transport | 14 | N |

*Source: Longlist Development and Evaluation, TCQ Working Paper (2019)*

## 9.3 Shortlist options

Based on the results of the evaluation, subsequent sensitivity testing and consolidation of a number of similar options, five representative congestion pricing schemes were identified to take forward to the shortlist stage for further development and analysis. These were:

1. **City Centre Cordon:** vehicles are charged to enter/exit the city centre (in the peak direction) using ANPR technology. While not one of the top ranked options, primarily due to its limited geographical coverage and corresponding limited potential for impact on overall network performance, the City Centre Cordon represents a low risk and internationally comparable scheme, which could potentially provide the first stage of a larger, more comprehensive scheme. An overseas example of a cordon scheme is found in Stockholm.
2. **Isthmus Area:** trips entering and travelling within the isthmus area are charged during congested periods using ANPR. This option was selected over the larger Urban Area scheme, to represent a 'medium' scale scheme, focussed on the area that is generally best served by public transport. The London Congestion Charge is an example of an area charging scheme.
3. **Strategic Corridors:** vehicles are charged to travel on congested corridors based on road hierarchy during congested periods using ANPR. An overseas example of a corridor scheme is the Singapore scheme.
4. **Strategic Corridors and City Centre Cordon ('Combination'):** a combination of shortlist options 1 and 3 (hybrid). Gothenburg has a combination scheme with a central city cordon and some additional strategic corridors outside the cordon that are charged.
5. **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 GNSS/cellular in-vehicle hardware. There is no international precedent for this type of scheme.

These options represent a spectrum of pricing schemes, from a small localised scheme to a region-wide scheme that would be highly flexible and targeted, ranging in complexity and ease of implementation.

Several of the longlist options (parking policy, car sharing, public transport fares and reverse tolling) were not considered sufficiently effective on a stand-alone basis but could be included as part of a broader demand management toolkit associated with a congestion pricing scheme.

The five options are discussed below, with an indicative map for each, which was used for transport modelling purposes.

### 9.3.1 Option One: City Centre Cordon

The City Centre Cordon scheme (Figure 36) charges vehicles 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 public transport services and high active-mode share for trips to the city centre.
- Other – impact is constrained by relatively small number of city centre commuter trips made by private vehicles.

**FIGURE 36: CITY CENTRE CORDON MAP**

### 9.3.2 Option Two: Isthmus Area

The Isthmus Area scheme (Figure 37) charges vehicles 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 public transport services on main routes.
- Other – will capture large number of resident workers travelling within the isthmus area.

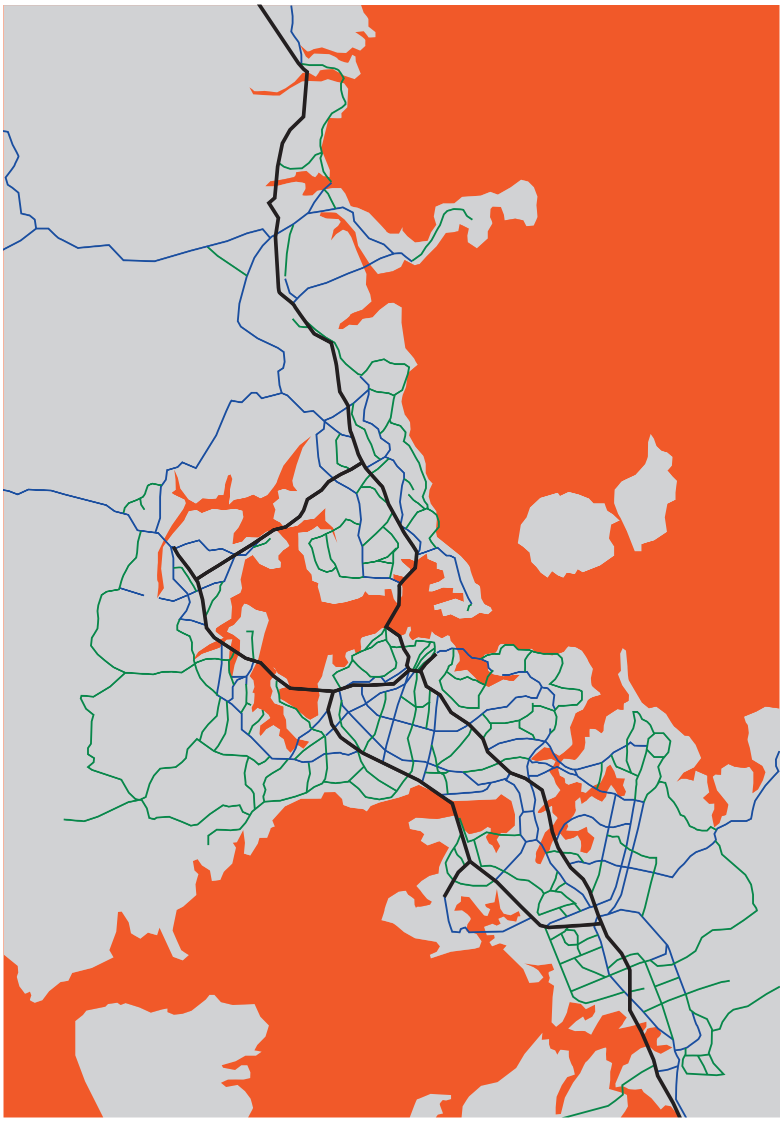
**FIGURE 37: ISTHMUS AREA MAP**

### 9.3.3 Option Three: Strategic Corridors

The Strategic Corridors scheme charges vehicles to travel on Auckland's strategic and arterial network in the Auckland region (links coloured black, blue and green in Figure 38):

- Objective – reduce congestion on state highways and arterial routes.
- Coverage – targets commuters travelling on 220 km of state highways and the main arterial road network across the Auckland region.
- Travel alternatives – main arterials are generally characterised by availability of public transport services.
- Other – may encourage some diversion onto the suburban road network. However, many arterial links have limited alternatives.

**FIGURE 38: STRATEGIC CORRIDORS MAP**

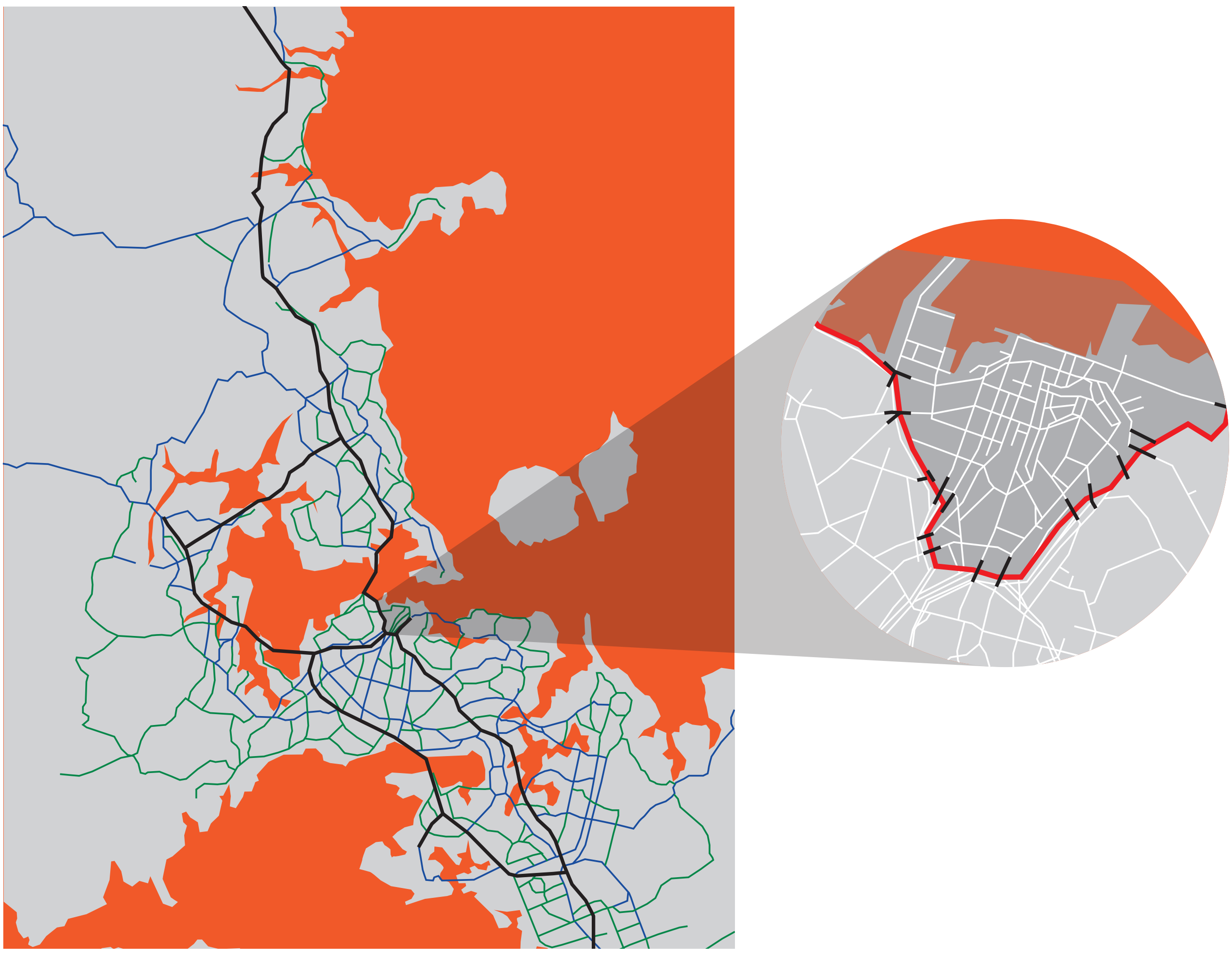


### 9.3.4 Option Four: Combination of Strategic Corridors and City Centre Cordon

The Combination scheme (Strategic Corridors plus City Centre Cordon) charges vehicles to travel on the strategic network and travel into and out of the city centre (see Figure 39):

- Objective – reduce congestion on strategic routes and discourage peak-period private vehicle 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 are generally characterised by the availability of public transport services.
- Other – the scheme aims to suppress vehicle travel in the city centre and capture dispersed peak-period trips across the Auckland region.

**FIGURE 39: STRATEGIC CORRIDORS AND CITY CENTRE CORDON MAP**



### 9.3.5 Option Five: Regional Network

The Regional Network scheme (Figure 40) charges vehicles to travel according to trip distance, time and location, using in-vehicle GNSS capable hardware:

- Objective – reduce congestion across the wider Auckland road network.
- Coverage – the scheme potentially includes the entire road network (all roads shown in Figure 40) noting that there is no intention to charge on uncongested routes at uncongested times. Drivers are warned in advance about tariff rates and journey costs.
- Travel alternatives – city centre routes and main arterials are generally characterised by availability of public transport services.
- Technology – in-vehicle GNSS hardware for vehicle detection will be required, along with ANPR for enforcement.
- Other – vehicle identification and payment arrangements will need to be made for occasional, tourist and out-of-town travellers.

**FIGURE 40: REGIONAL NETWORK MAP**

# 10 SHORTLIST OPTIONS EVALUATION

This section presents the results of the evaluation of the five shortlist options against the following criteria, as specified by TCQ's Terms of Reference:

**A.** **Network assessment** generated by modelling of shortlist options by the Auckland Forecasting Centre (AFC) using the Macro Strategic Model (MSM) to provide a range of data and outputs, to measure the impact of pricing options on the performance of the Auckland network (compared with the 2028 Regional Land Transport Plan (RLTP), which in turn, reflects implementation of transport projects as per ATAP)[46].

**B.** **Practical assessment** of shortlist options based on overseas experience and benchmarks, including consideration of scalability/flexibility, enforcement, privacy, risks and costs.

**C.** **Social assessment** of main equity and distributional impacts of congestion pricing on households and businesses.

**D.** **Environmental assessment** of forecast impact on environmental outcomes associated with the shortlist options.

**E.** **Cost benefit analysis (CBA)** of the economic costs and benefits associated with the shortlist options.

Due to the nature of the shortlist options, both a quantitative and qualitative approach to evaluation was undertaken by TCQ.

## 10.1 Network assessment

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, environmental and CBA assessment activities. The baseline scenario (or base case) in the model was set at 2028 and assumes the improvements included in the RLTP have been made to the transport network. Attributes of each option were then modelled, and the resulting network impacts were captured. The modelling followed an iterative process, with the congestion charges being adjusted several times depending on the magnitude of the improvement in network performance. Final charge values modelled were $2.30 for the cordon/area schemes and $0.12/km for the corridors/network schemes[47].

46 https://www.transport.govt.nz/land/auckland/atap/
47 The MSM transport model can support a time and location based fixed charge which is levied on each trip detected, or charges can be levied on a per km basis.

### 10.1.1 Performance metrics

Key performance 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 15.

Table 15 reflects the modelled change in the morning peak only. This does not report the full picture of changes that are occurring, for example changes in the time of day of some trips. This is the main reason why there is a difference when comparing the reduction in number of vehicle trips with the increase in forecast public transport trips[48].

**TABLE 15: NETWORK PERFORMANCE MODELLING RESULTS**

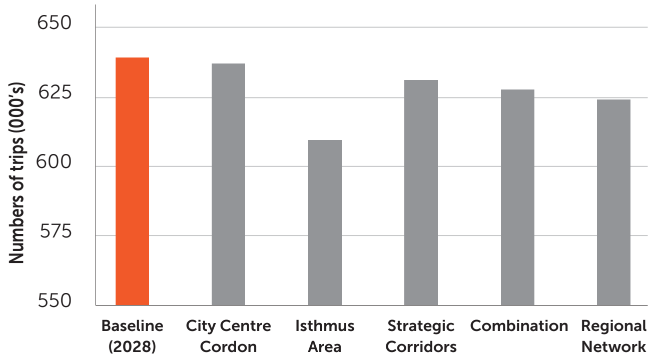
| | City Centre Cordon | | Isthmus Area | | Strategic Corridors | | Combination | | Regional Network | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Value | % | Value | % | Value | % | Value | % | Value | % |
| Number of vehicle trips reduces by: | 2,489 | 0.4% | 29,898 | 4.7% | 8,317 | 1.3% | 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 in hours (compared with efficient conditions) reduces by: | 1,514 | 4.2% | 9,280 | 26% | 10,857 | 30.4% | 12,369 | 34.6% | 11,726 | 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 | - |

*Source: Auckland Forecasting Centre*

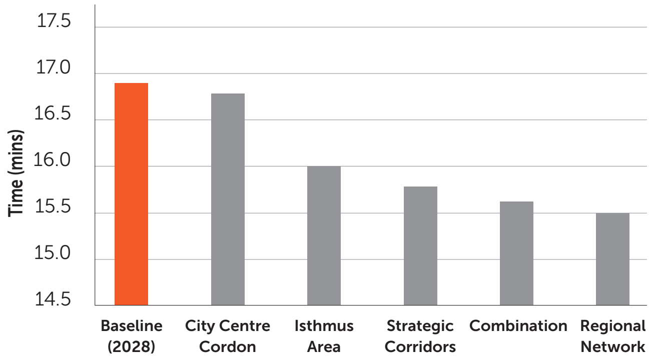
48 Note that some trips will simply no longer take place.

Considering each metric individually gives an indication of each option's performance when compared with all the other options. Figure 41 to Figure 46 illustrate the relative performance of each option against the baseline and against each other, for various key metrics[49].

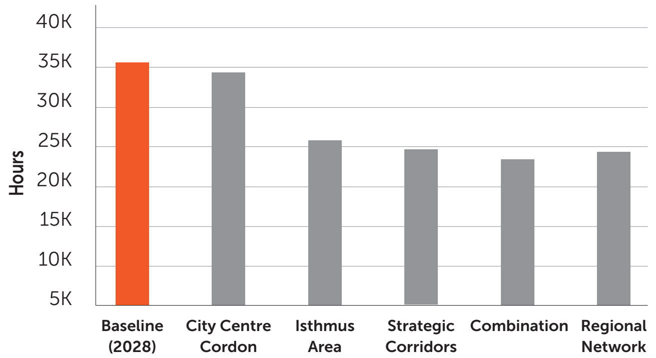
### FIGURE 41: NUMBER OF VEHICLE TRIPS PER AM PEAK



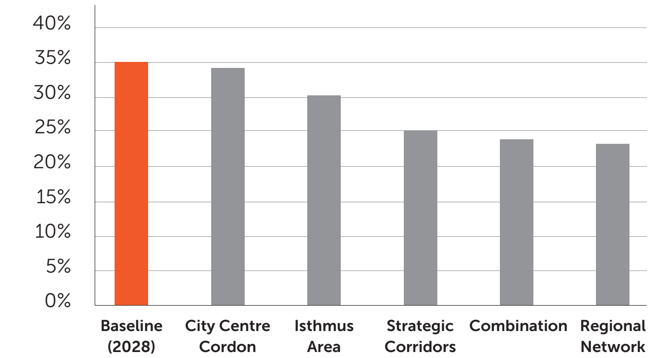

### FIGURE 42: AVERAGE VEHICLE TRAVEL TIME PER AM PEAK TRIP



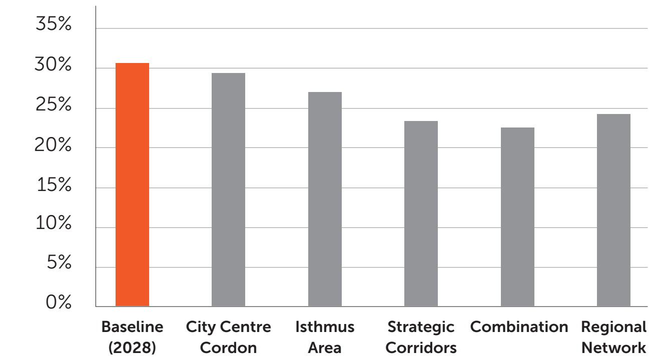

### FIGURE 43: HOURS OF TRAVEL TIME DELAY PER AM PEAK COMPARED WITH EFFICIENT CONDITIONS



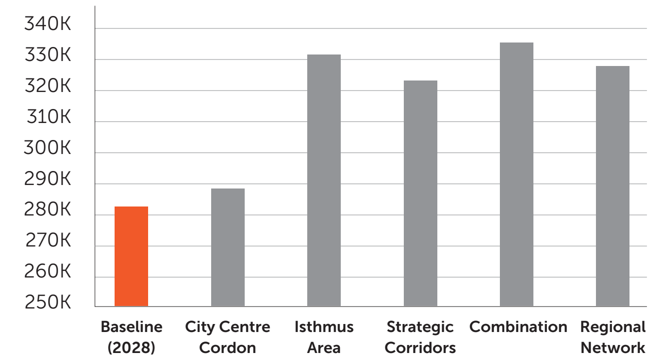

### FIGURE 44: PROPORTION OF TRAVEL TIME SPENT IN SEVERE CONGESTION




### FIGURE 45: PROPORTION OF FREIGHT VEHICLE KILOMETRES TRAVELLED IN SEVERE CONGESTION ON THE STRATEGIC FREIGHT NETWORK




### FIGURE 46: NUMBER OF JOBS ACCESSIBLE WITHIN 30 MINUTES DRIVE




49 Shortlist Evaluation, TCQ Working Paper (2019)

## 10.1.2 Main findings

1. The City Centre Cordon covers a small area and has a limited impact on overall network performance as shown by the small reductions in Table 15, mainly targeting home to work trips.
2. The Isthmus Area scheme has the largest reduction in number of vehicle trips, but less impact on network performance because it focuses on a smaller spatial area than the Strategic Corridors, Combination and Regional Network schemes (as shown in the comparison of travel time, travel time delay and time spent in severe congestion metrics).
3. The Strategic Corridors scheme is targeted and generates meaningful, region-wide network performance benefits and congestion relief.
4. The Strategic Corridors and Combination schemes have similar impacts in terms of network performance, with small additional improvements to network performance observed in the Combination scheme due to the addition of the City Centre Cordon (ie the effects are additive).
5. The Regional Network scheme achieves similar network performance outcomes to both the Strategic Corridors and Combination schemes and does not offer any noticeable additional congestion relief or network performance benefits.

## 10.2 Practical assessment

For the practical assessment, each shortlist option was reviewed against five criteria[50]:

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

Capital expenditure required to set up each option and the operating costs of each option were estimated based on knowledge of overseas congestion pricing schemes and New Zealand toll schemes. These cost estimates, along with revenue data from the MSM, were used in the CBA discussed below in Section 10.5.

### 10.2.1 Main findings

1. The Strategic Corridors and Regional Network schemes are the most scalable because they can be expanded incrementally. The Strategic Corridors scheme could also be piloted on a small scale.
2. Flexibility for the Regional Network option is limited by the need for OBUs and a parallel ANPR system for enforcement and visitors/occasional users.
3. The cost and complexity of enforcing the City Centre Cordon and Strategic Corridors schemes would be lowest because chargeable events are simple to detect (by matching a number plate to a location).
4. Enforcement of the Isthmus Area and Regional Network schemes is more complex and costly due to the requirement for extensive ANPR roadside infrastructure. (The extent of coverage would depend on compliance requirements and congestion reduction targets.)
5. Privacy protections are required for all options, but the Regional Network scheme raises additional privacy concerns because in-vehicle OBUs collect time and location data for all trips, including uncharged road segments.
6. ANPR technology is low risk, as it is a well-proven technology that is cost effective.
7. 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.
8. Highest risks are for the Regional Network and Isthmus Area schemes. There are no overseas precedents yet for a large area scheme or a congestion scheme that has deployed GNSS in-vehicle hardware for light vehicles.

50 Advanced Technical Review, D'Artagnan Consulting (2019)

## 10.3 Social assessment

Congestion pricing can be contentious because some road users obtain net benefits from time savings while others may find it more difficult to bear the additional costs as they do not sufficiently benefit from the travel time savings or may not have practical options for avoiding those costs. A major goal of TCQ is to design a scheme that is effective in terms of network performance and, on balance, acceptable in terms of the community's perception of transport benefits and costs resulting from the new charging regime. It is therefore important that the key impacts of pricing on those using the transport system, businesses and households, including fairness, equity and distributional impacts, are understood and appropriately addressed.

### 10.3.1 Methodology

The social assessment adopted the following methodology:

- The AFC's MSM is used to simulate trips taken within Auckland with and without congestion pricing. The MSM estimates some impacts of congestion pricing (particularly route and mode changes) but does not adequately capture trip suppression (the trips that are not made) or trip chaining (multiple-purpose / stop-start trips). The MSM outputs are in the form of origin-destination matrices, including trip numbers and trip costs.
- The trips are distributed to households within the trip origin areas using:
    a. Trip rates for different household types taken from the Ministry of Transport's Household Travel Survey (HTS).
    b. Statistics NZ Census data on household numbers by type and location.
- Price elasticities are applied to modelled household private vehicle trips and costs to estimate the total travel demand response, including impacts on mode choice.
- Differences between the results for the base case and those with a congestion charge are estimated. This includes differences in trip rates and costs, by location and household type. The analysis focuses on changes in travel costs resulting from the congestion charge as a percentage of household income.

The business analysis is more straightforward than it is for households. The analysis assumes, as a first approximation, that there is no price response beyond that estimated by the MSM. The MSM simulates some changes to routes based on changes in relative costs, but assumes businesses pay the charge rather than change trips to avoid it. Impacts for businesses in aggregate are then generated based on the modelled employer business trips and freight trips.

### 10.3.2 Average household cost increases

Table 16 shows weighted average costs as a percentage of income across all household types. The costs are the sum of costs across all trip types (to work or education and other trips) and modes (car and public transport). All options have higher proportional costs for low income households.

**TABLE 16: OPTION COMPARISON: HOUSEHOLD INCOME BANDS AVERAGE INCREASE IN COSTS (% OF ANNUAL INCOME)**

| Income level | City Centre Cordon | Isthmus Area | Strategic Corridors | Combination | Regional Network |
|---|---|---|---|---|---|
| Low | 0.00% | 0.52% | 0.41% | 0.46% | 1.61% |
| Medium | 0.00% | 0.28% | 0.20% | 0.23% | 0.76% |
| High | 0.00% | 0.15% | 0.11% | 0.13% | 0.40% |
| **All Households** | **0.00%** | **0.23%** | **0.17%** | **0.20%** | **0.65%** |

*Source: Congestion Pricing Options for Auckland: analysis of distributional effects, Covec & MRCagney (December 2018)*

Costs are highest for the network option, partly reflecting the assumed cost of in-vehicle technology required to operate the scheme. The Isthmus Area scheme has the second highest costs, with the Strategic Corridors and Combination options in between. Average costs when distributed across all Auckland households are very low for the City Centre Cordon charge, but this is a result of the fact that the MSM predicts that only 3% of peak-period trips would incur the congestion charge as set out in Table 17 below. Costs for households that regularly face the $2.30 charge would be much higher: in the order of $1,000 per annum depending on their commuting patterns.

**TABLE 17: PERCENTAGE OF TRIPS FACING THE CONGESTION CHARGE**

| | City Centre Cordon | Isthmus Area | Strategic Corridors | Combination | Regional Network |
|---|---|---|---|---|---|
| Auckland Region | 3% | 35% | 59% | 59% | 74% |

*Source: Congestion Pricing Options for Auckland: analysis of distributional effects, Covec & MRCagney (December 2018)*

### 10.3.3 Impacts on low income households

Table 18 shows the average cost increases as a percentage of annual income for low income households, by local board area (LBA)[51]. For the Regional Network option, costs are estimated to be as high as 2.1% of household income in Rodney. For the Strategic Corridors and Regional Network options the estimated average impact is largely a reflection of the average length of the trip. For the Isthmus Area scheme, the estimated impact reflects the forecast peak-period trip origins and destinations.

**TABLE 18: OPTION COMPARISON: COST INCREASES PER LOW INCOME HOUSEHOLD PER ANNUM (% OF ANNUAL INCOME)**

| LBA | City Centre Cordon | Isthmus Area | Strategic Corridors | Combination | Regional Network |
|---|---|---|---|---|---|
| Rodney | 0.02% | 0.15% | 0.69% | 0.72% | 2.06% |
| Hibiscus & Bays | 0.02% | 0.09% | 0.49% | 0.53% | 1.69% |
| Upper Harbour | 0.02% | 0.19% | 0.59% | 0.65% | 1.79% |
| Kaipātiki | 0.00% | 0.21% | 0.37% | 0.43% | 1.59% |
| Devonport-Takapuna | 0.00% | 0.18% | 0.32% | 0.37% | 1.51% |
| Henderson-Massey | 0.01% | 0.32% | 0.48% | 0.54% | 1.64% |
| Waitākere Ranges | 0.02% | 0.39% | 0.23% | 0.32% | 1.68% |
| Waitematā | 0.00% | 0.48% | 0.23% | 0.25% | 1.22% |
| Whau | 0.00% | 0.93% | 0.25% | 0.32% | 1.46% |
| Albert-Eden | 0.00% | 0.72% | 0.16% | 0.19% | 1.26% |
| Puketāpapa | 0.00% | 1.19% | 0.26% | 0.28% | 1.49% |
| Ōrākei | 0.00% | 1.00% | 0.20% | 0.27% | 1.42% |
| Maungakiekie-Tāmaki | 0.00% | 1.50% | 0.39% | 0.47% | 1.68% |
| Howick | 0.01% | 0.38% | 0.42% | 0.46% | 1.66% |
| Māngere-Ōtāhuhu | 0.01% | 0.49% | 0.44% | 0.47% | 1.72% |
| Ōtara-Papatoetoe | 0.01% | 0.30% | 0.48% | 0.51% | 1.69% |
| Manurewa | 0.00% | 0.13% | 0.33% | 0.34% | 1.63% |
| Papakura | 0.00% | 0.10% | 0.58% | 0.58% | 1.90% |
| Franklin | 0.00% | 0.09% | 0.66% | 0.66% | 1.76% |
| **Auckland Region** | **0.00%** | **0.52%** | **0.41%** | **0.46%** | **1.61%** |

*Source: Congestion Pricing Options for Auckland: analysis of distributional effects, Covec & MRCagney (December 2018)*

51 Note that Aotea/Great Barrier and Waiheke LBAs are excluded from the results as there is no expectation that congestion pricing would be implemented on these islands.

### 10.3.4 Business impacts

The impacts on business from the introduction of congestion pricing are estimated to be generally positive. This is because business trips experience savings in 'on the clock' time that offset the added financial cost of the congestion charges. Table 19 shows the impact of the options on costs as a percentage of transport related business costs[52]. Under most options, costs are expected to reduce, due to modelled reductions in travel time.

Table 19 also shows the absolute change in business costs for the Auckland region. It ranges from an estimated $4 million cost for the Isthmus Area scheme to a $10 million benefit generated from the Combination scheme.

**TABLE 19: OPTION COMPARISON: CHANGE IN BUSINESS COSTS AS A PERCENTAGE OF BASE COSTS**

| | City Centre Cordon | Isthmus Area | Strategic Corridors | Combination | Regional Network |
|---|---|---|---|---|---|
| Auckland Region | -0.4% | 0.4% | -0.5% | -0.9% | -0.5% |
| Absolute Change in Business Costs | -$4.3m | $4.4m | -$5.5m | -$9.8m | -$5.8m |

*Source: Congestion Pricing Options for Auckland: analysis of distributional effects, Covec & MRCagney (December 2018)*

### 10.3.5 Main findings

1. In line with overseas evidence, all the shortlist options generate higher costs as a percentage of income for low income households. The added burden for lower-income households creates a case for potential mitigations to support these households.
2. Business impacts are generally positive because overall travel costs decline due to the time savings generated more than offsetting the cost of the charge.
3. Across the Auckland region, average 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 and active travel 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 significant 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.
6. Estimated impacts for the Combination option are in line with the Strategic Corridors scheme, but the addition of the City Centre Cordon 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.

52 Modelled business costs include fuel, parking, public transport fares and cost of travel time.

## 10.4 Environmental assessment

The key environmental benefit of congestion pricing occurs through reducing total vehicle kilometres travelled (VKT), therefore using less fuel, thus reducing the volume of emissions of both greenhouse gases and air quality contaminants. An increase in average speed across the network (by reducing time spent in stop-start driving conditions and allowing more efficient use of fuel) could also have a positive impact on air quality.

Overseas, the improvement of the local environment has also been a consideration for congestion pricing schemes. Improvement in air quality has varied, with some schemes reporting city or region-wide improvement and others reporting localised improvements. Supported by other policies, Stockholm recorded 10–14% less emissions in the inner city, generating positive long-term health effects and a perceived enhancement of the city environment[53]. In London, localised improvement in air quality has been observed, but city-wide improvement has been hard to quantify. The existing London congestion pricing scheme is being reinforced by the introduction of an ultra-low emissions zone (ULEZ), which is expected to reduce local road transport emissions by upwards of 45%[54].

It is difficult to fully quantify the environmental benefits of any potential scheme without a study commissioned specifically for such a purpose, but the results of the transport modelling, set out in Table 20, do suggest that the shortlisted congestion pricing schemes are forecast to generate a modest decline in emissions from transport sources. Actual reductions are likely to be quite localised and depend on the nature of the traffic on a particular stretch of road and how people respond to the charge.

The introduction of an Auckland congestion pricing scheme has the potential to support an improvement in local air quality and reduce greenhouse gas emissions. This would also align with a range of national and local level policies and strategic directions regarding climate change, water quality and air quality. These issues are becoming increasingly important given Auckland Council's declaration of a climate emergency and recent establishment of the national Zero Carbon Act.

**TABLE 20: FORECAST TRANSPORT EMISSIONS (2028)**

| | Baseline | City Centre Cordon | Isthmus Area | Strategic Corridors | Combination | Regional Network |
|---|---|---|---|---|---|---|
| $CO_2$ emissions (kg daily) | 9,229,102 | 9,218,112 | 9,203,982 | 9,152,755 | 9,165,902 | 9,150,691 |
| VOC emissions (kg daily) | 4,180 | 4,171 | 4,157 | 4,138 | 4,128 | 4,128 |
| $NO_x$ emissions (kg daily) | 18,337 | 18,320 | 18,299 | 18,230 | 18,209 | 18,205 |
| $PM_{10}$ emissions (kg daily) | 1,031 | 1,030 | 1,028 | 1,024 | 1,023 | 1,023 |

*Source: Auckland Forecasting Centre*

53 Congestion charging: building upon the Stockholm experience, M Lundberg (2019)
54 London prepares for launch of ultra-low emissions zone, G Topham, Guardian (2019)

## 10.5 Preliminary cost benefit analysis (CBA)

A preliminary CBA was undertaken as part of the shortlist evaluation to be considered along with the findings from the network performance, social, environmental and practical assessments[55]. Because the objective of TCQ is not limited to generating the highest benefits (or benefit cost ratio (BCR)), the overall evaluation exercise requires consideration of all five evaluation aspects to determine the main findings and subsequent recommendations. This also means that although high tariffs would generate greater improvements in network performance, they would also significantly worsen social impacts, which is inconsistent with TCQ's Terms of Reference.

Capital expenditure required to establish 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 transport modelling exercise, were then used in the subsequent CBA.

Costs and benefits presented below are in 2018 dollars, unless noted otherwise.

### 10.5.1 Shortlist scheme costs

The estimated cost of each of the shortlisted option is displayed in Table 21. Periodic opex (operating expenditure) relates to the renewal of systems and infrastructure every seven years. The Regional Network option has significantly higher costs associated with it due to the OBU requirements as discussed in the technology discussion in Section 8.2.

**TABLE 21: SHORTLIST CAPITAL EXPENDITURE (CAPEX) AND OPERATIONAL EXPENDITURE (OPEX) COSTS**

| | Option Costs ($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: Cost benefit analysis, TCQ Working Paper (2019)*

55 Cost benefit analysis, TCQ Working Paper (2019)

### 10.5.2 Estimated scheme benefits

The annual conventional transport benefits for each option are detailed in Table 22. Benefit calculations are consistent with Waka Kotahi's Economic Evaluation Manual (EEM) methods and the relevant values of time, emissions and vehicle operating costs. 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 (Table 20). It is acknowledged that this is a narrow view of environmental impacts, given the impacts from land transport on water quality and other ecological systems, visual amenity, ambient noise and noise exposure effects. These impacts tend to be difficult to quantify and monetise.

The estimated economic benefits of the schemes are likely to be higher when wider factors, such as wider economic benefits, labour supply impacts, improved productivity and liveability (outside the scope of a conventional transport appraisal), are incorporated.

As expected, due to its scale, the City Centre Cordon option produces only modest annual benefits compared to the other four options, which may generate in the order of $200 million of benefits each year.

**TABLE 22: ANNUAL BENEFITS**

| | Annual benefits ($m) – based on 2028 modelled year | | | | |
|---|---|---|---|---|---|
| | 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 |
| $CO_2$ 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: Cost benefit analysis, TCQ Working Paper (2019)*

### 10.5.3 Cost benefit summary

Taking a 23-year evaluation period, to include implementation and then two renewals of systems and infrastructure (and allowing for discounting and annual growth in benefits), the CBA summary (showing present value (PV), net present value (NPV) and BCR) is shown in Table 23.

All the options generate a positive NPV and a 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. Realised benefits for all options are likely to be higher, leading to a higher BCR, as per the discussion in Section 10.5.2 relating to the fact that there are a number of benefits that are difficult to quantify and monetise.

**TABLE 23: BENEFITS AND COSTS FOR EACH OPTION**

| Option | PV Benefits ($m) | PV Costs ($m) | NPV ($m) | BCR $_{(N)}$ |
|---|---|---|---|---|
| City Centre Cordon | 305 | 182 | 124 | 1.7 |
| Isthmus Area | 2,047 | 936 | 1,111 | 2.2 |
| Strategic Corridors | 2,148 | 1,216 | 932 | 1.8 |
| Combination | 2,433 | 1,283 | 1,150 | 1.9 |
| Regional Network | 2,734 | 3,852 | -1,118 | 0.7 |

*Source: Cost benefit analysis, TCQ Working Paper (2019)*

## 10.6 Shortlist evaluation summary

1. The City Centre Cordon covers a small area and is likely to have a limited impact on overall network performance, mainly targeting home to work (commuting) trips (albeit only the proportion travelling to the city centre). Small scale and proven technology translate 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. For these reasons, along with its comparability to overseas schemes and potential for public acceptability, this option may represent 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 overall 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 LBAs would be subject to a disproportionate share of charges.
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. The potential for diversion ('rat-running' to avoid roads that are included in the pricing scheme) will need to be considered when specifying which corridors are (and are not) charged. 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 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 individual options as a combined package. That said, there are also no observed detrimental effects when compared to the Strategic Corridors option.
5. The Regional Network option achieves a small incremental improvement to network performance over the Strategic Corridors option but has the lowest BCR because of high capital and operating costs. The requirement to install OBUs capable of collecting time and location data for all trips, including uncharged road segments, raises privacy and acceptability concerns. With no overseas precedent to date, 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 OBUs), with low income households disproportionately affected.

Based on the main findings outlined above, TCQ recommended that the City Centre Cordon and Strategic Corridors options were taken forward for further detailed investigation and analysis. With the selection of the two preferred schemes to be taken forward for further investigation, TCQ had the opportunity to undertake additional scheme refinement. The revised City Centre Cordon and Strategic Corridor spatial maps are presented in the Annex to this report.

# 11 ILLUSTRATIVE TARIFF CONCEPT

This section develops an illustrative tariff concept for Auckland for the two congestion pricing schemes identified in Section 10 as having the most potential for Auckland. The tariff concept and illustrative parameters described, represent the necessary components of an operational congestion pricing scheme. The discussion draws upon the review of congestion pricing policy, the international congestion pricing review, the shortlist evaluation and transport modelling exercise, and the observed travel patterns that characterise the Auckland network.

## 11.1 Preferred Auckland tariff structure

Section 6.2, discussed three potential charge structures that could be applied to an Auckland congestion pricing scheme:

- point-based charges
- access charges
- distance-based charges.

A distance-based charge was considered and rejected as part of the shortlist evaluation exercise. That exercise identified practical constraints, high capital and operating costs, and implementation risks associated with the supporting technology[56] required to operate a distance-based scheme at this time. This means that for Auckland, the decision comes down to a point-based or access tariff structure.

### 11.1.1 Common tariff parameters

Point-based and access tariff structures share a number of common positive features:

- Charges can vary by time, day and vehicle class.
- Initial implementation can be simple to understand (noting significant complexity could be introduced to either structure).
- The tariff structures can incorporate a wide variety of mitigation measures and exemptions/discounts.
- The tariff structures can be readily implemented using proven ANPR technology.

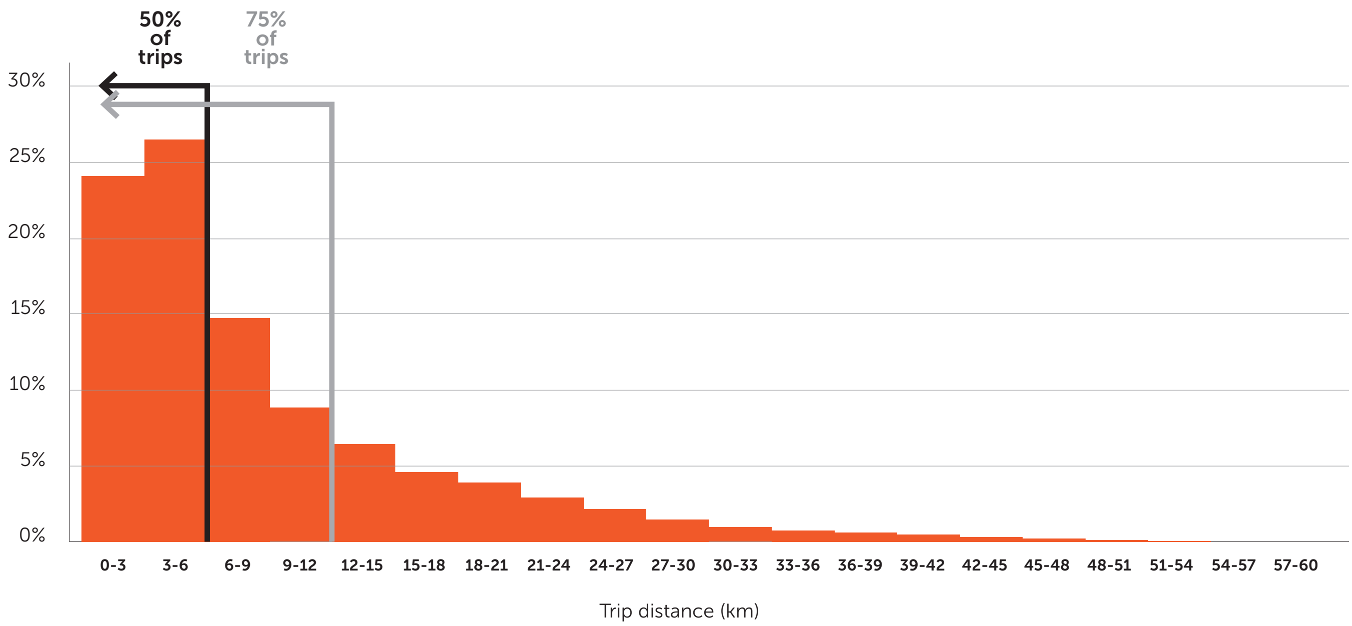
56 Evaluation of shortlist of road pricing options for Auckland: practical considerations, D'Artagnan Consulting (2018)

### 11.1.2 Point-based vs access tariff

The major difference between the two tariff concepts is the number of trips for which drivers are provided with sufficient incentive to change their behaviour. In particular:

- With point-based charges, network performance improvements are likely to be smaller because low effective charges on a cost per km basis may provide insufficient incentive for travellers who make shorter trips to change behaviour. Auckland's travel patterns are dispersed, and around 75% of trips are less than 12 km (trips to the left of the grey line in Figure 47 below), with over 50% being less than 6 km (trips to the left of the black line in Figure 47).
- With an access charge, higher effective charges on a cost per km basis for shorter trips will encourage behaviour change and mode shift by more travellers with flexibility.

**FIGURE 47: 2028 BASELINE MORNING PEAK TRIP LENGTH DISTRIBUTION (KM)**




*Source: Auckland Forecasting Centre*

Other differences between the two tariff structures are notable:

- Access charges are simple to understand as the charge is only dependent on time of travel.
- Point-based charges are more difficult to understand as charges are dependent on time of travel, and route taken.
- Access charges provide certainty for motorists of the charge that they will incur.
- With point-based charges motorists will not necessarily know in advance the charge they will face for their trip.
- Access charges only require one detection for an entire journey to trigger the charge, meaning there is little possibility of successfully evading the charge by diverting (rat-running).
- Point-based charges are charged at each detection, so there is a higher incentive to rat-run to avoid any individual charging point.

Drawing on the work undertaken in the social assessment (discussed in Section 10.3) and the nature of travel in Auckland (see Section 2), social considerations also lend support to the adoption of an access charge tariff for Auckland:

- Low charges on a per km basis for short trips under point-based charges will favour higher income central suburbs where residents generally make shorter trips.
- Cumulative charges from point-based charges may contribute to adverse social impacts (depending on mitigation options) because lower income households in outer suburbs will face higher charges due to longer average journeys.
- An access charge means all motorists travelling on chargeable roads at the same time face the same charge regardless of their origin and destination location.

### 11.1.3 Preferred tariff structure

Based on the evidence and analysis of potential tariff structures, TCQ recommends the adoption of an access charge for further development, evaluation and engagement.

## 11.2 Network performance

The tariff concept needs to be underpinned by a view around the level and nature of the improvement in network performance that would be required from the introduction of congestion pricing for the two preferred shortlist options. The overall magnitude of the target level of improvement in network performance has to reflect the ability for peak-period car trips to realistically respond to congestion pricing through mode or time changes or other behaviour changes such as ride sharing, or simply not travelling. The expected response will in turn reflect existing travel patterns, mode shares and transport infrastructure availability within the Auckland region.

Overseas schemes were observed to have demand responses to the introduction of congestion pricing within the range of 15-20% reduction in traffic. An achievable improvement in network performance for Auckland is more likely to be in the order of 8-12%, given the underlying travel patterns and availability of practical alternatives like public transport. This level of network improvement is currently evident during the school holidays. This is comparable with the long-term reduction achieved in Gothenburg, a small city with a comparable public transport mode share to Auckland.

Social considerations will also limit the level of network performance improvement that could otherwise be achieved through higher tariffs.

## 11.3 ILLUSTRATIVE TARIFF PARAMETERS

Table 24 brings the analysis together to generate a comprehensive tariff concept suitable for both recommended congestion pricing schemes. The values associated with the parameters are preliminary, and further refinement is likely to be undertaken over time to enhance and expand any Auckland congestion pricing scheme.

The level of charges adopted is the key component of the proposed tariff concept because it determines the pricing structure that motorists face and consequently the resulting network, spatial, social, and environmental impacts. There are a range of tools to assist policymakers to determine the starting congestion charge values, but ultimately this exercise must be resolved by professional judgement, taking into account:

- results from transport modelling exercises
- local topographical and economic features
- existing journey to work and education patterns
- achievable target levels of service for Auckland
- the availability and cost of public transport and active mode travel alternatives
- benchmarking against results achieved by overseas congestion pricing schemes.

Once operational, the starting charges would be reviewed against the network performance achieved, as well as the observed practical, social, environmental and spatial impacts.

**TABLE 24: ILLUSTRATIVE TARIFF PARAMETERS**

| Parameter | Definition / Value | Rationale |
|---|---|---|
| **Charge levels (per PCU)** | **City Centre Cordon and Strategic Corridors Scheme**<br>• $3.50: Peak period<br>• $2.50: Peak/Shoulder period<br>• $1.50: Shoulder period<br>• $0: Interpeak period<br>• $0: Off peak period | As a general comparison, the starting peak tariff value is approximately equal to the adult two-zone fare using an AT HOP card ($3.55 in Feb 2020).<br>Traffic modelling and overseas examples demonstrate that there are declining and marginal benefits to network performance achieved through higher tariffs.<br>Social considerations are also likely to cap the level of tariffs.<br>The starting tariff values will be further analysed and amended if a decision is made to implement a congestion pricing scheme. |
| **Daily charging caps** | The maximum charge incurred in a 24-hour period will be 2x the maximum peak-period charge. | The introduction of daily maximum charges helps to mitigate excessive negative financial impacts for travellers who have a limited ability to switch modes, change departure times or defer their travel. Daily caps may also be a sensible response for commercial vehicles, such as couriers, required to undertake numerous trips as part of their business activities.<br>The daily caps are based on two peak time charges. This reflects the fact that a typical commuter vehicle would incur two peak time charges per day. A vehicle that incurs additional daily charges is likely to be required to undertake trips that are non-discretionary, and therefore a cap is required to limit the financial burden imposed by the scheme. In addition, mitigation measures (discussed below) are likely to be required to address impacts on financially vulnerable users. |

#### TABLE 24: ILLUSTRATIVE TARIFF PARAMETERS (CONT)

| Parameter | Definition / Value | Rationale |
|---|---|---|
| **Trips and journeys** | Any vehicle movement is defined as a trip.<br>A trip that is captured by an ANPR camera at a charging location within a chargeable time band triggers a charge levied against the vehicle.<br>A journey includes all trips within a two-hour period from the time the vehicle is first detected by the ANPR network. | An objective of the scheme is to ensure motorists are aware that trips undertaken during congested conditions will incur a charge. However, many trips are of a stop-start nature (trip chaining), such as school drop-offs undertaken before the driver commutes to work. Because the access charge is not cumulative, a definition of a chargeable event is required.<br>The concept of a journey, which is defined as any number of vehicle movements detected within a two-hour period, provides certainty for motorists around the potential charges they will face and helps avoid artificially distorting travel patterns. This gives people a two-hour 'journey window' where they will only incur one charge (see below). This is a familiar concept, as Auckland's public transport network provides for journeys across multiple bus and rail trips using an AT HOP card (up to five trips in a four-hour window depending on the fare zone).<br>Two hours has been defined as the initial journey window as it needs to be sufficiently long to ensure that the majority of single purpose trips can be completed (eg commute to work). It also needs to be sufficiently long to avoid perverse outcomes such as encouraging chained trips to occur in shorter timeframes, potentially increasing congestion. The journey window can be reviewed over time, though it is unlikely that a duration of less than 90 minutes would be appropriate, especially if daily caps are applied. |
| **Charge rules** | Vehicles incur the highest charge detected within the journey window (two hours).<br>The two-hour journey window is defined as beginning when a vehicle is first detected by the ANPR network. | An objective of the scheme is to ensure motorists are aware that trips undertaken during congested conditions will incur a charge. However, trips within the two-hour journey window may take place over multiple time bands. Because the access charge is not cumulative, a rule is required to determine which tariff should apply to the vehicle's journey.<br>The concept of charging motorists for the highest tariff incurred during their journey captures their maximum estimated contribution to congestion and best supports the scheme's objectives. The charging rule is simple and helps avoid perverse behaviour or artificially distorting travel patterns. |
| **Time** | • Charges initially only apply during the morning and afternoon peaks<br>• Charges vary by time bands<br>• Time bands are 30 minutes<br>(Refer illustrative tariff schedule in Section 11.4) | Banded charges help to manage and spread demand and avoid perverse time-boundary behaviour, such as that observed with the London scheme that has a single charge levied for the entire workday.<br>This is achieved through a graduated series of steps in charges up to a peak rate (and down again).<br>Thirty-minute bands enable a practical number of graduated steps across a three-and-a-half-hour charging period, while not being overly difficult to understand at the introduction of a scheme. |
| **Travel days** | • Monday – Friday only<br>• Weekends and public holidays are exempt | Reducing congestion is desirable to increase economic productivity. As weekday (Monday – Friday) travel is dominated by work-related (economically productive) trips, charging these days will deliver the greatest gains in productivity.<br>In overseas schemes, weekends and holidays are also exempt from congestion charges except in Singapore where charges are applied on Saturdays.<br>The introduction of weekend/holiday charging is not precluded in the future. |

**TABLE 24: ILLUSTRATIVE TARIFF PARAMETERS (CONT)**

| Parameter | Definition / Value | Rationale |
| --- | --- | --- |
| **Exemptions** | • Emergency vehicles<br>• Buses (vehicles with >9 seats)<br>• Motorcycles/scooters<br>• Non-powered road registered vehicles (trailers) | A small number of road-registered vehicles should be exempt from charges for a number of reasons, while not undermining the effectiveness of the scheme.<br>Overseas, emergency vehicles are universally exempt.<br>Public transport buses are exempt in all schemes (except Singapore) because there is no demand response expected from them and government actively promotes greater uptake of bus travel by the public. Complications arise around buses where scheduled and/or private chartered services can be delivered by the same buses. To avoid undue complexity in administering bus exemptions, it is proposed that all buses, defined as having more than nine seating positions (including the driver's seating position), should be exempt. Any unintended consequences of this exemption are expected to be negligible given the proportion of journeys fulfilled by non-public bus services.<br>Motorcycles and scooters are exempt on the grounds that they make a minor contribution to congestion in Auckland (noting that they are charged in Singapore).<br>Non-powered road registered vehicles (trailers) are exempt on the grounds that to be contributing to congestion they will be attached to a powered vehicle that is already subject to the charge.<br>There may be other minor vehicle classes considered for exemption (eg military vehicles) as the scheme policy is refined during detailed design. |
| **Discounts** (refer to Section 15 for further discussion) | • Community services card holders<br>• Disability and mobility users | The application of targeted discounts (or rebates) may be a valid response to mitigate undesirable social and spatial impacts associated with congestion pricing.<br>It is important to be careful about applying discounts to maintain scheme credibility and effectiveness.<br>For mitigation of socio-economic impacts, the Community Services Card could be an appropriate eligibility test, with:<br>• discounts linked to the eligible person's legally owned vehicle, and/or<br>• account credits linked to the eligible person's scheme account.<br>If mitigation is found to be necessary for disability and mobility users, then:<br>• modified vehicles that are certified by the Low Volume Vehicle Technical Association could be exempt<br>• the maximum subsidy for the existing Total Mobility Scheme in Auckland could be increased to offset any increases that may otherwise be passed onto eligible people.<br>Note that the level of discount will be decided as the scheme policy is refined during detailed design. |
| **Direction of travel** | For the City Centre Cordon scheme, charges are only proposed to apply:<br>• inbound in the morning charging period<br>• outbound in the afternoon charging period.<br>For the Strategic Corridor scheme, no application of directional charging (outside the motorway network) is practical or necessary at this time. | Traffic congestion is often related to directional flows influenced by travel to and from employment centres and therefore charges should ideally reflect trip directions.<br>For the city centre, there is a clear directional flow in the morning/afternoon and directional charging could be applied.<br>For the Strategic Corridor scheme, applying directional charging would need to be applied on a corridor-by-corridor basis. This introduces undue complexity with regard to both technical application and user understanding.<br>From a technical perspective, the exception to this might be the motorway network, where each direction could be treated independently. However, the dispersed nature of Auckland's congestion means that in most locations, congestion is rarely directional. Most trips at peak times on strategic corridors will be contributing to congestion, at least for part of the trip, and should be charged accordingly.<br>Future evolution of the scheme may deem some level of directional charging appropriate and practical, and this is not precluded. |

## 11.4 Illustrative tariff schedule

The illustrative tariff schedule showing the 30-minute charging time bands and associated charges for an access-based tariff for light vehicles, are shown in Table 25.

These are preliminary and would be subject to refinement (particularly the start and end of the morning and afternoon charging periods) through detailed design, and periodic review.

**TABLE 25: ILLUSTRATIVE TARIFF SCHEDULE – MONDAY–FRIDAY**

| Time | Period | Tariff |
|---|---|---|
| 06:00-06:29 | Shoulder | $1.50 |
| 06:30-06:59 | Shoulder/Peak | $2.50 |
| 07:00-07:29 | Peak | $3.50 |
| 07:30-07:59 | Peak | $3.50 |
| 08:00-08:29 | Peak | $3.50 |
| 08:30-08:59 | Peak/Shoulder | $2.50 |
| 09:00-09:29 | Shoulder | $1.50 |
| 09:30-15:29 | Interpeak | $0.00 |
| 15:30-15:59 | Shoulder | $1.50 |
| 16:00-16:29 | Shoulder/Peak | $2.50 |
| 16:30-16:59 | Peak | $3.50 |
| 17:00-17:29 | Peak | $3.50 |
| 17:30-17:59 | Peak | $3.50 |
| 18:00-18:29 | Peak/Shoulder | $2.50 |
| 18:30-18:59 | Shoulder | $1.50 |
| 19:00-05:59 | Off-peak | $0.00 |

## 11.5 Trip/journey examples

Below are five illustrative examples of how the tariff parameters would apply to some hypothetical journeys using the Strategic Corridors scheme, along with the charges those trips would incur.

Any specific roads named are assumed to have ANPR cameras installed to capture passing traffic.

In addition to the illustrative charge, the impact of a daily cap of $7 is presented to demonstrate the impact from applying this form of mitigation. The daily cap is assumed to be twice the peak charge as described above. Note also that the daily cap value could be adjusted.

### 11.5.1 Short-distance commuter

A Remuera resident works in Newmarket and they drive their car to work. The travel distance is 3 km each way. They leave home at 07:40 and arrive at work at 07:55. They make the return trip in the afternoon, leaving work at 17:05 and arriving home at 17:20.

| | Access-based charging |
|---|---|
| Total charges incurred | $7.00 |
| Apply rule: daily cap of $7 | $7.00 |

### 11.5.2 Long-distance commuter

A Takanini resident works in Mt Wellington and they drive their car to work. The travel distance is 20 km each way. They leave home at 07:10 and arrive at work at 08:15. They make the return trip in the afternoon, leaving work at 16:45 and arriving home at 17:40.

| | Access-based charging |
|---|---|
| Total charges incurred | $7.00 |
| Apply rule: daily cap of $7 | $7.00 |

### 11.5.3 Courier vehicle driving around the network all day

A courier van travels around the city on chargeable corridors during both chargeable and non-chargeable periods.

| | Access-based charging |
|---|---|
| Total charges incurred | $9.50 |
| Apply rule: daily cap of $7 | $7.00 |

### 11.5.4 Long travel, with an example of the impact if they shifted time of travel

A Henderson resident is going to visit their friend in Clevedon for lunch. They decide to leave home at 09:15 and go to Sylvia Park on the way to Clevedon. The return home in the afternoon by 15:45.

| | Access-based charging |
|---|---|
| Total charges incurred | $3.00 |
| Apply rule: daily cap of $7 | $3.00 |

**Variation**

If the driver had postponed their morning departure by 20 minutes, they would have started their morning journey outside the morning congestion pricing peak period. The resulting charges would be:

| | Access-based charging |
|---|---|
| Total charges incurred | $1.50 |
| Apply rule: daily cap of $7 | $1.50 |

### 11.5.5 Multi-purpose morning peak travel

A Grey Lynn resident uses their vehicle to make an early morning trip to the gym and home again by 06:40, then drops their children to school on their way to work in the city centre, arriving at 08:55.

| | Access-based charging |
|---|---|
| Total charges incurred | $5.00 |
| Apply rule: daily cap of $7 | $5.00 |

**Variation**

The next day, they repeat their trip to the gym at the same time, returning home by 06:40, but decide to walk their children to school and then walk to work afterwards as the weather is nice. The resulting charges are:

| | Access-based charging |
|---|---|
| Total charges incurred | $2.50 |
| Apply rule: daily cap of $7 | $2.50 |

Part four

# SOCIAL EVALUATION

**This section provides a detailed social evaluation of the preferred congestion pricing schemes. The international review found that an inability to articulate a satisfactory response to concerns about equity impacts is a key contributing factor to the failure of abandoned schemes. 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.**

**The detailed social evaluation has four components:**

12. **Social Assessment**: presents the results of the refined social assessment to assess the financial effect of a potential congestion pricing scheme on Auckland and Māori households.

13. **Mana Whenua Assessment**: presents the results of an initial impact assessment on Mana Whenua in Tāmaki Makaurau.

14. **Vulnerable Households Assessment**: presents the results of the market research exercise undertaken to assess the impact of a potential congestion charge on vulnerable Auckland households.

15. **Mitigation Measures**: outlines a possible mitigations policy, to target road users or households that may require compensation for the financial burden of any congestion pricing scheme.

# 12 SOCIAL ASSESSMENT

This section presents the results of the updated social assessment exercise undertaken to estimate the level of financial burden incurred by Auckland household groups following the introduction of a congestion pricing scheme. The revised social assessment is confined to the full Strategic Corridors scheme; the preliminary assessment found that average equity impacts are likely to be modest for the City Centre Cordon scheme because of the small number of trips impacted and wide availability of public transport alternatives.

## 12.1 Study scope

The initial social assessment study, presented in Section 10.3, analysed the financial impact of the five shortlist charging options on households in low, medium and high income categories[57]. The updated social assessment study extends the original methodology to consider Māori households in Auckland. Benefits generated from trip time and reliability improvements are ignored by the analysis, although these would typically be included in a comprehensive study.

The analysis in this section employs the same methodology and assumes:

- a congestion charge of $0.20/km for trips taken during morning and afternoon peaks on the strategic corridors that are subject to a charge[58].

The study examines the impacts on households classified:

a) as all households
b) as Māori households
c) by income category
d) by LBA.

### 12.1.1 Māori household trip rates

Household trip rates – that is the number of trips per household in each peak period – differ with the structure of the household. This is defined by the number of people and the number of vehicles present in each household. There was no basis to adopt different trip rates by income level, or for Māori and non-Māori households[59]. Impacts differ by LBA within Auckland because of different trip characteristics (their length and the extent to which they face the congestion charge) and differences in the mix of household types. Within each LBA and in total, average financial impacts relative to income differ between Māori and other households to the extent that there are differences in mean income.

## 12.2 Social assessment results

### 12.2.1 Changes in trips

The methodology developed for TCQ extends the traditional MSM analysis by applying household demand elasticities, derived from empirical research, to support the modelling exercise to generate realistic estimates of the impact that congestion pricing could have on peak-period vehicle trip numbers. This approach also has the effect of bringing the forecast reduction in vehicle trip numbers from the introduction of congestion pricing more in line with the overseas evidence presented in Section 5.

Table 26 shows the changes, estimated by the social assessment model, in numbers of trips for the Auckland region when the Strategic Corridors scheme is implemented. The estimated reduction in car trips includes trips that have shifted to public transport, those that have changed the time of the trip, and those which are suppressed completely.

57 *Congestion Pricing Options for Auckland: analysis of distributional effects*, Covec & MRCagney (December 2018)
58 Testing of the peak ($3.50) access charge proposed in Section 11 cannot be accurately reflected in the Auckland MSM. A congestion charge of $0.20/km was chosen as a proxy for an access charge and is broadly equivalent to the City Centre Cordon and Area scheme charge of $2.30 adopted for the shortlist evaluation once average trip lengths and journey times are taken into account.
59 A similar approach was adopted by Sapere (2018).

TABLE 26: CHANGES IN CAR AND PUBLIC TRANSPORT TRIPS FROM THE BASE CASE

| Income group | Car trips | PT trips |
|---|---|---|
| Low | -12.0% | +6.8% |
| Medium | -11.8% | +6.7% |
| High | -11.7% | +6.7% |
| All households | -11.8% | +6.7% |

*Source: Congestion Pricing in Auckland: analysis of effects on households and business, Covec & MRCagney (October 2019)*

## 12.2.2 Average household costs

Financial costs for households are calculated from projections of total trips taken in Auckland that would pay the congestion charge and the estimated amounts paid. This varies with the origin and destination of the trips (calculated by MSM) and the change in trip patterns in response to the congestion charge (calculated using elasticities) levied under the Strategic Corridors scheme. Table 27 shows the total morning peak trips and the percentage that are charged, for each LBA[60]. The percentage charged varies from 25% in Franklin to 88% in Ōtara-Papatoetoe, reflecting the travel patterns and the types of trips made, as estimated by MSM.

TABLE 27: MORNING PEAK HOUSEHOLD TRIPS BY LBA AND PERCENTAGE FACING THE CONGESTION CHARGE

| LBA | Total car trips | Car trips charged | % facing charge |
|---|---|---|---|
| Ōtara-Papatoetoe | 34,521 | 30,431 | 88% |
| Albert-Eden | 48,990 | 43,170 | 88% |
| Devonport-Takapuna | 26,099 | 22,229 | 85% |
| Puketāpapa | 25,729 | 21,554 | 84% |
| Upper Harbour | 39,933 | 32,308 | 81% |
| Maungakiekie-Tāmaki | 46,667 | 37,477 | 80% |
| Māngere-Ōtāhuhu | 27,639 | 21,887 | 79% |
| Whau | 32,405 | 24,219 | 75% |
| Kaipātiki | 36,288 | 26,493 | 73% |
| Henderson-Massey | 48,545 | 33,116 | 68% |
| Waitematā | 33,967 | 22,770 | 67% |
| Howick | 65,656 | 43,695 | 67% |
| Ōrākei | 44,244 | 28,633 | 65% |
| Papakura | 24,816 | 15,081 | 61% |
| Manurewa | 28,694 | 16,717 | 58% |
| Waitākere Ranges | 20,106 | 10,129 | 50% |
| Hibiscus & Bays | 40,845 | 18,246 | 45% |
| Rodney | 32,859 | 8,640 | 26% |
| Franklin | 37,673 | 9,411 | 25% |
| **Auckland region** | **695,678** | **466,205** | **67%** |

*Source: Congestion Pricing in Auckland: analysis of effects on households and business, Covec & MRCagney (October 2019)*

60 Note that Aotea/Great Barrier and Waiheke LBAs are excluded from the results as there is no expectation that congestion pricing would be implemented on these islands.

The total charge paid in each LBA is allocated to the household types in each LBA. This is then aggregated to the Auckland region to estimate the average charge paid by each household type as a percentage of average household income (Table 28). Costs are:

- greater for high income households than for low income households because they tend to be larger households and take more trips
- more significant as a percentage of mean household income for low income households
- not significantly different as a percentage of income between Māori and other households.

**TABLE 28: AVERAGE COST OF THE CONGESTION CHARGE (PERCENTAGE OF ANNUAL INCOME)**

| Income level | All households | Māori households | Other households |
|---|---|---|---|
| Low | 0.83% | 0.83% | 0.83% |
| Medium | 0.43% | 0.43% | 0.43% |
| High | 0.25% | 0.25% | 0.25% |
| Average | 0.36% | 0.36% | 0.36% |

*Source: Congestion Pricing in Auckland: analysis of effects on households and business, Covec & MRCagney (October 2019)*

Table 29 shows, for each LBA, the average cost increases as a percentage of mean annual income, for all households, Māori households and by income category.

**TABLE 29: COST INCREASES PER HOUSEHOLD PER ANNUM (PERCENTAGE OF ANNUAL INCOME)**

| LBA | All households | Māori households | Low Income | Medium Income | High Income |
|---|---|---|---|---|---|
| Ōtara-Papatoetoe | 0.65% | 0.60% | 1.00% | 0.48% | 0.30% |
| Māngere-Ōtāhuhu | 0.56% | 0.56% | 0.94% | 0.44% | 0.25% |
| Henderson-Massey | 0.51% | 0.50% | 0.75% | 0.39% | 0.22% |
| Papakura | 0.50% | 0.50% | 0.92% | 0.46% | 0.27% |
| Upper Harbour | 0.48% | 0.42% | 0.91% | 0.44% | 0.26% |
| Maungakiekie-Tāmaki | 0.48% | 0.51% | 0.79% | 0.37% | 0.20% |
| Howick | 0.39% | 0.35% | 0.71% | 0.36% | 0.21% |
| Whau | 0.38% | 0.36% | 0.54% | 0.28% | 0.15% |
| Puketāpapa | 0.36% | 0.34% | 0.69% | 0.31% | 0.17% |
| Manurewa | 0.36% | 0.36% | 0.74% | 0.34% | 0.20% |
| Kaipātiki | 0.35% | 0.33% | 0.55% | 0.29% | 0.16% |
| Devonport-Takapuna | 0.35% | 0.30% | 0.55% | 0.28% | 0.17% |
| Albert-Eden | 0.33% | 0.30% | 0.51% | 0.23% | 0.15% |
| Rodney | 0.28% | 0.29% | 0.54% | 0.28% | 0.17% |
| Waitākere Ranges | 0.27% | 0.26% | 0.41% | 0.23% | 0.13% |
| Franklin | 0.26% | 0.27% | 0.58% | 0.31% | 0.19% |
| Waitematā | 0.26% | 0.24% | 0.44% | 0.18% | 0.13% |
| Hibiscus & Bays | 0.25% | 0.23% | 0.35% | 0.21% | 0.13% |
| Ōrākei | 0.23% | 0.22% | 0.40% | 0.19% | 0.12% |
| **Auckland region** | **0.36%** | **0.36%** | **0.63%** | **0.31%** | **0.18%** |

*Source: Congestion Pricing in Auckland: analysis of effects on households and business, Covec & MRCagney (October 2019)*

There are significant differences between LBAs. Costs vary from 0.23% (Ōrākei) to 0.65% (Ōtara-Papatoetoe) of mean annual household income across all households, and from 0.22% to 0.60% of mean income for Māori households. This is calculated as the average cost of the congestion charge (which reflects the types of trips taken from that LBA) divided by the average income in the LBA. The estimated financial impacts will reflect the number of households by income group in each LBA and the percentage of trips facing the charge in each LBA.

Individual households may pay more or less than the estimated averages presented in Table 29. Some households may make no trips during the peak periods (for example, workers with flexible hours or retired people). Others could be charged for multiple trips during peak periods (for example, households with several working adults).

### 12.2.3 Financial impact on Māori households

Compared to the average impact on all households, financial impacts on Māori households are:

- greater in Maungakiekie-Tāmaki, Franklin and Rodney
- the same in Māngere-Ōtāhuhu, Manurewa and Papakura
- lower in all other areas.

To a significant extent, these differences reflect the distribution of Māori households across low, medium and high-income bands. The areas where the impacts are greater for Māori households are areas where a higher proportion of Māori households are low income than for other households.

When the analysis is undertaken by income category, the differences are more pronounced. Costs vary from 0.12% of annual income of high-income households in Ōrākei to 1% of income of low-income households in Ōtara-Papatoetoe.

### 12.2.4 High cost scenario

Table 28 presents the estimated annual average cost of the congestion charge per household as a percentage of annual income. To understand the level of charges a household could potentially face in a worst-case scenario, TCQ examined possible costs for households when all their estimated peak-period trips were charged (compared to the average of 67% of trips for all Auckland households).

Table 30 shows that for households where all peak-period trips are subject to congestion pricing, there is an increase in the estimated financial impacts for all income groups, rising to 3.3% of annual income for some large low-income households with more than one vehicle. The effects could be even larger if the income level of a specific household were lower than average and there would also be regional variations across individual LBAs.

**TABLE 30: HIGH COST SCENARIO OF THE CONGESTION CHARGE (PERCENTAGE OF HOUSEHOLD INCOME)**

| Household type | Percentage of mean income | | |
|---|---|---|---|
| | Low | Medium | High |
| 1 or 2 persons with 1+ vehicles | 0.8% | 0.3% | 0.1% |
| 3 persons with 1+ vehicles | 1.6% | 0.6% | 0.3% |
| 4 or more persons with 1+ vehicles | 3.3% | 1.2% | 0.6% |
| All households | 1.2% | 0.6% | 0.4% |

*Source: Congestion Pricing in Auckland: analysis of effects on households and business, Covec & MRCagney (October 2019)*

### 12.2.5 Main findings

The social assessment exercise is highly complex and is limited by the level of disaggregation in the available information (including household income and travel pattern data) and the adoption of various simplifying assumptions in the modelling. Nevertheless, the analysis is informative and indicates that a number of households may face a significant and unavoidable increase in transport costs because of congestion pricing. These are households that do not have a realistic opportunity to avoid peak-period charges because they may have inflexible work/education schedules and no viable public transport or active mode alternative. The question of the most appropriate mechanism(s) to address these matters is discussed in Section 15.

# 13 MANA WHENUA ASSESSMENT

This section provides a summary of an initial assessment of how the two preferred congestion pricing schemes could impact Mana Whenua in Tāmaki Makaurau and recommends actions to be carried out in any subsequent stage of TCQ[61]. The intention is that the assessment is to be used as a starting point for Mana Whenua input and possible decision-making.

The Mana Whenua assessment notes that Mana Whenua were engaged during the prior stages of the ATAP project. The outcome was that Mana Whenua supported the finding that something needed to be done to address congestion on the Auckland roading network.

## 13.1 Scope

The Mana Whenua assessment builds on previous advice setting out relevant factors that could determine the impact of TCQ on Māori in Tāmaki Makaurau, in particular Mana Whenua. The Mana Whenua assessment:

- identifies components of Mana Whenua identity and wellbeing
- considers how the City Centre Cordon and Strategic Corridor options overlap with these components
- explains and assesses the effects of the schemes on Mana Whenua identity and wellbeing
- recommends next steps for any future phases of TCQ.

The Mana Whenua assessment is qualitative in nature and focusses on a wider set of potential effects stemming from the operation of a congestion pricing scheme, in addition to the estimated financial impacts identified in the social assessment.

## 13.2 Methodology

The two preferred congestion pricing options were compared against information contained in the Te Waharoa database. The Te Waharoa resource was developed and is managed by the Auckland Transport Māori Strategy and Engagement Team. It maps layers, such as places of importance, and associated information and brings together key information about Māori and Mana Whenua of Tāmaki Makaurau into one geo-spatial platform.

The Te Waharoa database is capable of holding and overlaying project information with the Māori information layers to visually capture project and Māori interest overlaps. The supporting information can be used to understand the potential impacts of the project on Māori communities.

After comparing areas of overlap, an assessment of effects was carried out, based on an understanding of Mana Whenua use and level of access to these places and a review of relevant Mana Whenua submissions and iwi management plans.

For the purpose of this analysis, determining the impact on Mana Whenua was framed using the Auckland Plan definition of Māori identity and wellbeing:

**Direction 1**: Advance Māori wellbeing – thriving Māori identity and wellbeing means whānau, hapū, iwi and Māori communities lead healthy and prosperous lives where their housing, employment, education and health needs are met. Two key pathways have led to successful outcomes for Māori:

- the role of marae as focal points for social, cultural and economic development
- the delivery of services 'by Māori, for Māori, based on te ao Māori values and practices'.

61 The Congestion Question – Mana Whenua Analysis, Kristy Hill (2020)

**Direction 2**: Promote Māori success, innovation and enterprise – an Auckland of prosperity and opportunity for all seeks to advance and support Māori business and iwi organisations to be significant drivers of the Auckland economy.

**Direction 3**: Recognise and provide for Te Tiriti o Waitangi outcomes – for whānau, hapū, iwi and Māori communities in Tāmaki Makaurau, recognising Te Tiriti outcomes include access to culture and traditional taonga and mātauranga. This means delivery for Māori, as Māori, through Māori organisations in relation to:

- a flourishing language
- access to customary Māori arts and culture
- activities and initiatives that support Māori development.

## 13.3 Main findings

The assessment using Te Waharoa suggests that both the City Centre Cordon and Strategic Corridor options are likely to have some negative impacts on Mana Whenua wellbeing and identity.

The key conflict between the potential introduction of congestion pricing and a thriving Mana Whenua wellbeing and identity is the constraint that charges may impose on Mana Whenua access to and engagement with places of importance. Such access provides a significant and necessary contribution to Mana Whenua wellbeing and identity. Places of importance to Mana Whenua include places:

- that define Mana Whenua identity
- where tikanga (Māori custom) determines behaviour and conduct
- where cultural obligations and benefits are fulfilled
- where Treaty redress obligations, including collective commercial interests, are fulfilled.

In assessing the degree to which the potential congestion pricing scheme impacts on Mana Whenua wellbeing and identity, the impact is determined by three factors:

1. Location: the proximity of places of importance to the charged areas.
2. Accessway: the requirement to use the charged roads to access places of importance.
3. Time: the need to access places of importance during times subject to congestion pricing.

The impact of congestion pricing is likely to be greater where these places of importance are located within or where access is necessary through areas and at times that are subject to congestion pricing. There is likely to be a lesser, but relevant, impact on Mana Whenua whose places of importance are close to the scheme areas.

The extent of this impact will increase for those who deal with this restriction on a daily basis (eg papakāinga communities), or for places that support regular traditional practices that cannot easily be rescheduled (eg tangi (funerals)).

Comparing the schemes, the assessment found that the Strategic Corridor option affects more Mana Whenua groups in a more substantial way than the City Centre Cordon option. This is due to the area that the Strategic Corridor option covers being larger, and the reasons for which Mana Whenua access places within the City Centre Cordon area, compared to places in the Strategic Corridor area.

It is also important to consider that any constraints on Mana Whenua to move about, access and engage in these places, can be compounded when one considers the cumulative effects of historical restrictions. Given Mana Whenua and TCQ Partners' Treaty partnership commitments, including the priority outcomes set out in the Auckland Plan, it will require consideration to avoid or mitigate any impact, even if, on the face of it, the impacts may seem minor.

In order to assess the impact from the introduction of a congestion pricing scheme as positive, the outcome from pricing will need to actually facilitate greater access. The ability for congestion pricing to improve access for Mana Whenua can be determined by Mana Whenua during engagement. The question is whether the negative impact of restricting Mana Whenua access can be offset by the potential improvement in access by restricting others' movement.

In this context, the Mana Whenua assessment notes that a gradual roll out of congestion pricing, beginning with the City Centre Cordon option, for example, and involving Mana Whenua during the monitoring phase, will help to inform these matters.

## 13.4 Implementation considerations

The initial assessment of how the two preferred congestion pricing schemes could impact on Mana Whenua in Tāmaki Makaurau also included a number of recommended actions to be carried out if the decision is made to undertake subsequent work to support a move towards implementation. In particular the Mana Whenua assessment recommended that any subsequent phases of TCQ should have four key areas of focus:

1. building on the initial assessment of impacts on Mana Whenua
2. Mana Whenua engagement
3. mitigation option development
4. decision-making.

### 13.4.1 Mitigation measures

The initial assessment identifies that congestion pricing will have some likely negative impacts on Mana Whenua. Where these impacts are not able to be avoided, mitigation options that address areas of particular concern should be developed with Mana Whenua. In particular, substantive mitigation options should be considered particularly where access to places of importance to fulfil traditional practices during the congestion pricing periods are identified.

The Mana Whenua assessment notes that there are three mitigation options that could be developed:

1. boundary adjustments to the congestion pricing scheme options
2. discounts or waivers for Mana Whenua members or holders of cultural obligations
3. allocation of funds collected applied towards Mana Whenua outcomes.

While there might be some practical constraints around these mitigation options, offering substantive relief demonstrates a strong intention to deliver on commitments to Mana Whenua and Treaty relationships.

# 14 VULNERABLE HOUSEHOLDS ASSESSMENT

This section extends the social assessment to focus on vulnerable Auckland households that could be affected by the introduction of a congestion pricing scheme. The assessment is based on a series of interviews undertaken with 50 households located across the Auckland region. The assessment is qualitative in nature and focusses on a wider set of potential effects, such as likely impacts on people's transport choices and the potential for any adverse wellbeing outcomes stemming from the operation of a congestion pricing scheme, in addition to the financial impacts examined in Section 12.

## 14.1 Methodology

The focus of the assessment was to explore the possible impacts that a congestion pricing scheme might have on financially vulnerable road users through face to face interviews, with those people being defined as:

- a person who would be exposed to a congestion charge at least three times a week
- a person who showed some degree of financial vulnerability in that they had either lower income, a low 'financial buffer', or experienced some difficulty paying bills.

A total of 50 people were interviewed from across Auckland, with other recruitment considerations including:

- recruiting people from a range of ethnicities (the sample includes eight Māori, seven Pacific and seven Indian participants)
- a bias towards lower household incomes (34 of the total sample had a household income below $70k per annum).

Interviews were conducted face to face and participants were asked to describe their weekly peak-period travel. The Strategic Corridors option was introduced, and participants were assisted in calculating their average weekly and monthly congestion charges using the illustrative tariff concept and values. Interviewers described both the costs (in terms of actual costs to the road users) and the likely benefits (in terms of the anticipated reduction in time spent in traffic), described as traffic levels equivalent to those experienced in school holidays.

## 14.2 Main findings

The results of the assessment provide an insight into how a sample of road users responded to the proposition of a congestion pricing scheme, in this case the Strategic Corridors option. The results highlighted that a lack of knowledge, familiarity and trust tends to exacerbate concerns. They also reinforce the strongly held belief that any pricing system needs to be fair. In this context fairness speaks to the ability of each road user to adapt their usage or pay a potential charge without incurring unnecessary hardship or inconvenience. Clearly, however, the charge needs to create some level of discomfort in order to achieve its goal of creating a motivation to make changes to travel.

This research illustrates what the limits of that discomfort are. It highlights the fact that discomfort is already being caused by the congestion itself. Many road users who find current levels of congestion intolerable have already made the decision to switch. These road users were not the focus of this study, however. The sample of interviewees comprises low-income road users who drive during peak hours largely because they believe they have no other choice.

Initial reactions to the idea of congestion pricing were largely a function of personal exposure (the size of the charge) and a road user's ability to adapt.

Road users tend to be more exposed to congestion charges if they are:

- multi-car households
- regular morning and evening commuters
- households with school children.

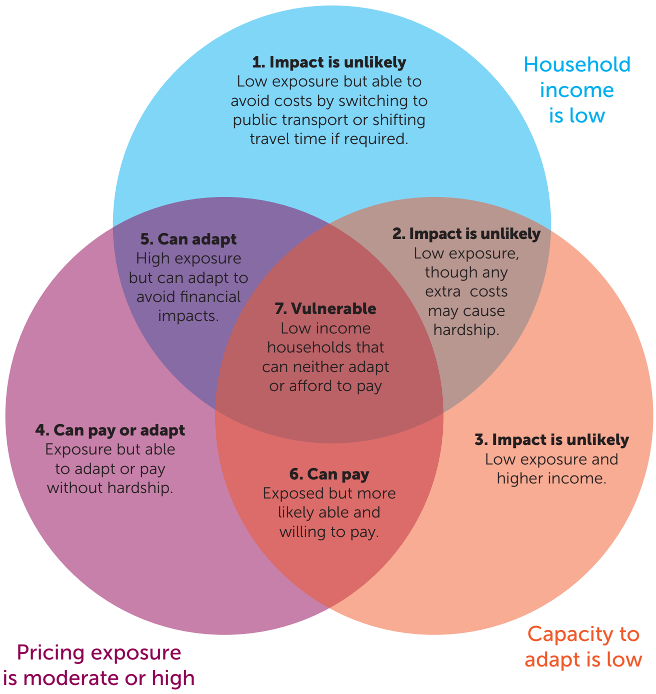
Roads users' ability to adapt was an outcome of two components:

1. The perceived ease and appeal of public transport options. (Importantly, there is a group of road users who do have the ability to adapt but under current circumstances choose not to. Introducing additional costs and promoting the ease and attractiveness of public transport alternatives is likely to drive change within this group.)

2. The ability and willingness to shift travel time or mode.

Figure 48 highlights the interaction between exposure and capacity to adapt. Those with low incomes who can't pay or adapt (segment 7) are the most likely to be vulnerable to adverse wellbeing outcomes.

## FIGURE 48: CONGESTION PRICING EXPOSURE AND ADAPTION CAPACITY




*Source: Congestion persona research: Insights into how road users might respond to the proposition of a congestion charge being implemented on Auckland roads, The Navigators (2019)*

For many of the interviewees, the idea of being charged for something they can't avoid feels grossly unfair. Likewise, road users who can adapt or pay are also highly sensitive to the plight of those more vulnerable road users who are either unable to pay or unable to change (and were the focus of the research).

The research highlighted a set of factors that appeared to influence both the initial emotional response of road users and the degree to which they viewed congestion pricing as acceptable. These will be important factors to consider in future communication and included:

- perceptions of congestion severity and urgency to address this issue for Auckland
- pre-existing knowledge of congestion pricing
- perceptions of the effectiveness of congestion pricing
- trust in government (both local and central)
- perceptions of fairness
- perceptions of freedoms being infringed.

A key purpose of this research was to identify how people's wellbeing might be affected by a potential congestion charge. Road users identified four key areas of impact:

1. **Adverse financial impacts**: the main impact raised by participants was the pressure that additional unavoidable congestion charges would have on household budgets. Participants identified increased debt levels, reduced food budgets and reduced financial resilience as the more severe adverse impacts a congestion charge would have on their households. Less severe impacts were described as reduction in discretionary spending and saving.

2. **Stress impacts**: participants described a range of stress impacts that could result from a congestion pricing scheme being put in place. These stress responses were both as a result of needing to pay the charges, but also stress around the need to plan travel to avoid charges and dealing with the additional administration tasks of making payments. For some, it was just one more thing to worry about.

3. **Impact of trips not taken**: exposed road users have essentially three options when responding to a congestion charge. They can pay, they can shift (mode or time), or they can choose not to undertake the journey that would expose them to the charge. Participants described two related effects that not taking these trips to avoid congestion charges would have:

   a. **Reduced community / sports / cultural participation**: several road users indicated they would choose to not take trips that incurred additional charges, especially when these trips already incurred costs (such as paid after-school activities). This raised concerns among many that the congestion charge might limit participation in sports or community or cultural activities.

   b. **Reduced social connection**: to reduce or avoid further congestion charges, discretionary trips like visiting family and friends would be the first to be given up by some participants. These trips, although discretionary, were still described as being important to them. Avoiding these social trips could lead to increased isolation and have negative effects on the wellbeing of individuals, families and the community more broadly.

## 14.3 Implementation considerations

In discussing the nature and impacts of potential congestion charges, a range of expectations, concerns and suggestions were raised that may have implications for the future design of a congestion pricing scheme, and for how it is communicated to users. These are summarised below.

1. Access to public transport is expected to be improved to allow road users to easily adapt.
2. Road users expect that road user charges/petrol tax would be reduced.
3. Road users expect that congestion pricing revenue should be put back into the community.
4. Road users expect that employers would need to be more flexible to enable employees to shift travel times.
5. Schools should be encouraged to shift their start and end times.
6. Road users would expect a pay rise where peak hour travel is required as part of their jobs.
7. Contractors / workers would pass on the extra costs to employers / clients.
8. Incentive to speed might become an unintended consequence.
9. Flexible payment plans should be put in place to help people manage budgets.
10. Congestion charges should be capped.

Finally, the insights identified through the research have implications for how best to engage with the public in a manner that both recognises the relatively early life stage of the congestion conversation in New Zealand and addresses some areas of concern that might affect greater public acceptance. These implications are outlined below.

1. **Do not assume a shared sense of urgency or shared view of the severity of the problem across people living in Auckland**. The congestion problem will need to be framed in a way that is relevant and meaningful for it to be acknowledged as something that requires significant change. Most road users do see congestion as a significant problem; however, this is mainly from a personal inconvenience perspective (frustration, time away from family). While some of the broader impacts of congestion such as environmental impacts were highlighted by participants, others weren't well understood or did not come to mind readily (eg, productivity, economic) when the topic of congestion pricing was raised.

2. **Build familiarity and understanding early and over time**. Raising awareness and starting conversations about how congestion pricing works and the benefits it can provide needs to happen early to avoid the type of emotional and shocked reactions from road users that were identified in this research. These reactions can affect an individual's ability to process and cope with the suggestion that they will need to pay to be on the road at certain times. Those already experiencing stress in their lives will likely be more impacted by this 'new news' than others.

3. **Expect road users to remain sceptical of benefit claims for some time, even in the face of evidence**. Providing meaningful and credible evidence of the benefits will be important to build trust. It is likely, however, that distrust of claims of benefits will linger until road users actually experience freer-flowing peak-period traffic as a result of a congestion pricing scheme being implemented.

4. **Address key concerns early**. Those leading the development of any congestion pricing scheme design will need to address key concerns raised in these interviews, primarily relating to:

   - issues of social justice and mitigating negative impacts on vulnerable road users
   - issues relating to authority, security, privacy and governance of the data collected by ANPR cameras.

# 15 MITIGATION MEASURES

While the benefits of congestion pricing focus on time savings and improvements in travel reliability, the social assessments emphasise the need to carefully consider mitigation for households that may face an unreasonable and unavoidable increase in transport costs due to the congestion pricing scheme implemented.

Determining what the exact financial burden will be on households is difficult. It is likely that that there are a significant number of vulnerable households who will face a significant financial cost from the implementation of a congestion pricing scheme. The design of the mitigation policy in this section, considers how to best target this group[62].

## 15.1 Design objectives

### Objective 1: Identify eligible households

Any mitigations policy should only be targeted to the group of road users who require compensation. This objective focuses on the welfare perspective – ensuring that those worse-off households are not unable to cope financially because of the scheme. The mitigations policy should identify and target mitigation towards households that incur excessive increased financial cost and who have low income, are vehicle dependent, make high value (or high scheduling cost[63]) trips at congested times, and cannot otherwise avoid the charge through behavioural change.

### Objective 2: Deliver an appropriate level of mitigation

For the group(s) deemed eligible under the policy, an appropriate level of mitigation should be delivered to adequately compensate or negate the negative welfare impact of the financial effect of the scheme. If possible, the level of mitigation should not exceed this level, nor under deliver, for the eligible households.

### Objective 3: Avoid undermining demand management objectives

The demand management objective of the scheme is to improve network performance through reduced congestion. To preserve this objective, the eligibility criteria, level, and mechanism of the mitigations policy should be limited to only what is necessary. Opportunities to gain benefit when not entitled (gaming the system) should be minimised where possible.

### Objective 4: Administrative efficiency

The mitigations policy should be implemented in a way that minimises operating costs and administrative burden. As far as possible, any mitigations policy should draw on existing systems, especially with respect to eligibility criteria, in order to maximise ease of use.

## 15.2 Policy options

### 15.2.1 Eligibility criteria

As with many social welfare policies, due to data availability and privacy concerns, there are limitations to perfectly identifying people who should be eligible for mitigations. In the first instance, eligibility criteria that use existing systems, such as the Community Services Card or the Total Mobility Scheme, will be more cost effective, simpler and easier to understand than those that require a new regime to be established.

The eligibility criteria used by the Community Services Card appears to be well aligned with the objective to identify people with low income who may face an unreasonable financial burden, especially where holders are restricted from changing their travel behaviour in response to congestion pricing.

62 *Mitigations Policy*, TCQ Working Paper (2019)
63 A limited ability to travel at another time, rather than when their time itself is valuable. For example, there is little flexibility in timing for a parent to pick up a child from kindergarten, whether they are employed or not.

Disability and/or mobility restrictions are not in themselves necessarily indicators of financial hardship, but they may often result in higher car-dependency and less access to alternative transport options. The eligibility criteria described for the existing Total Mobility Scheme and modified vehicles certified by the Low Volume Vehicle Technical Association appear to be best designed to test practical access to transport alternatives. Further engagement with these groups would be beneficial.

### 15.2.2 Mitigation delivery mechanism

When selecting a mitigation delivery mechanism, the following points need to be considered:

- targeting mitigation towards those who will experience genuine hardship from the scheme
- administrative simplicity and cost
- minimising the risk of gaming or perverse incentives.

A price subsidy offers a mitigation that is more targeted to how often eligible people use the scheme – scaling with high use and low use. For discounts, account credits and caps, an incentive is also retained for eligible participants to consider their travel behaviour and so contribute to reducing congestion. However, because a price subsidy is attached to an eligible vehicle, there is potential for any person to use the vehicle and receive the discount. Depending on the scale of the exemption, this may somewhat undermine the demand management objectives of the scheme.

In contrast, income subsidies are less targeted to how much an eligible person is exposed to the congestion pricing scheme. To illustrate, a grant for all eligible people could potentially lead to inequitable outcomes due to differences in travel demand and potential issues with how to target the subsidies to Auckland residents alone. However, income subsidies do not suffer the same gaming risk as price subsidies, where non-eligible drivers can avoid the scheme by driving an eligible person's vehicle.

On balance, a price subsidy is likely to be more effective. This is especially true if eligibility is sufficiently small – say, the 10% of the Auckland population who have Community Services Cards and own a vehicle. This limits the potential impact of non-eligible people using eligible people's vehicles.

A price subsidy could be provided through some combination of a discount or a credit to the user's scheme account. For a credit, additional work should be undertaken to consider if a credit can be transferable to the AT HOP card. A lower daily cap on the maximum payable in one day could also be considered, although this would need to be integrated into any policy to apply a daily cap to all users as proposed in the illustrative tariff policy discussed in Section 11.

### 15.2.3 Revenue implications

Any mitigations policy that uses a price subsidy for a targeted group of users will have impacts on the amount of revenue that the scheme collects. An income subsidy for the targeted group could be funded from scheme revenue.

## 15.3 Links with other aspects of TCQ

### 15.3.1 Scheme design

The implementation of the scheme over time can also help to mitigate financial impacts on low income households by being initially deployed in areas with better access to transport alternatives like public transport and high-quality walking and cycling connections (noting that these may not be in the most congested areas).

### 15.3.2 Tariff policy

Some of the justification for a mitigations policy depends on the final design of the tariff including possible daily maximum or trip caps and locations for implementation. The adopted tariff policy will also need to consider exemptions from the congestion charge (including those discussed earlier in Section 11.3).

### 15.3.3 Complementary measures

Using revenue from the scheme to benefit those geographies subject to the charge (such as improvements to public transport services and infrastructure to provide alternatives to vehicle trips) could be an effective way to mitigate the financial impact of the congesting pricing scheme for those who are affected. This is conditional on the assumption that vehicle users are able and willing to change modes.

## 15.4 Main findings

For the mitigation of financial impacts from the introduction of a congestion pricing scheme, TCQ considers that the Community Services Card (and eligibility criteria) could be adopted as the delivery mechanism using:

- discounts linked to the eligible person's legally owned vehicle
- account credits linked to the eligible person's scheme account.

If mitigation is found to be necessary for disability and mobility users, the scheme could:

- exempt modified vehicles certified by the Low Volume Vehicle Technical Association
- increase the funding to the existing Total Mobility Scheme to offset any increases in costs that may otherwise be passed on to eligible people (eg through increased taxi fares).

Additional consideration should be given to:

- whether any bespoke or retrospective mitigation should be provided to eligible people that do not own a vehicle but rely on family and caregivers to transport them
- whether changes to other Government welfare payments could be used to mitigate the impacts of congestion pricing on financially vulnerable people/households.

Part five

# SCHEME IMPLEMENTATION

**This section discusses the decisions that will be required to support the implementation of a congestion pricing scheme in Auckland. The implementation exercise will involve legislation, detailed design, procurement, delivery, and operations, and a comprehensive consultation and engagement programme. The preferred technology solution is discussed, and a number of implementation options are presented, along with an illustrative timetable:**

16. **Implementation Tasks**: the main tasks that will underpin the introduction of a congestion pricing scheme in Auckland.
17. **Rollout Options**: three different rollout options for an Auckland congestion pricing scheme.
18. **Illustrative Timetable**: an illustrative implementation timetable based on the preferred rollout option and the adopted Auckland RLTP.

# 16 IMPLEMENTATION TASKS

This section outlines the main tasks that will underpin the introduction of a congestion pricing scheme in Auckland. The implementation exercise will involve legislation, detailed design, procurement, delivery, operations, and a comprehensive consultation and engagement programme. The role of complementary measures, and potentially of demonstrations and pilots is also discussed. Finally, this section notes that the adoption of a revenue policy is a key implementation task.

## 16.1 Legislation

The introduction of a congestion pricing scheme in Auckland will require supporting legislation, as there are no provisions to enable it at present. This could be achieved by amending the Land Transport Management Act 2003 (LTMA). Alternatively, the Government may prefer to introduce new specific legislation solely for congestion pricing in Auckland. Either approach would require the legislation to address:

- the role of local government and road controlling authorities
- institutional arrangements and relationships with existing central and local government agencies
- how congestion pricing should sit within regional land transport plans
- requirements around public/community engagement
- the ability to set conditions
- the use/treatment and management of revenue
- the process for setting and reviewing tariffs and any discounts and exemptions
- any relationship with existing charges
- safeguards around personal information collected, in accordance with the Privacy Act 1993
- rules and processes around enforcement of the scheme.

It is expected that the process to draft, consult and pass supporting legislation for the purposes of congestion pricing would take approximately 12–18 months, once policy decisions to allow congestion pricing have been made by Cabinet. The timing is dependent on many factors, including complexity of the legislation to be drafted, the number of issues raised at select committee stage, and political priorities.

If the legislation for enabling congestion pricing follows the form already used under the LTMA to enable toll roads, then it would be necessary for an organisation such as Auckland Council or Waka Kotahi to formally submit an application to the decision-maker, which is expected to be the Minister of Transport. The scheme would then be approved through an Order in Council.

The application to establish the scheme would be expected to set out all relevant information responding to the bullet points above and to respond to any other matters included in the legislation. This would require a specific work programme to prepare the application. As we do not know what the process will be for establishing a congestion pricing scheme at this stage, we cannot estimate the length of time required to develop and then approve the application once legislation is in place. It is reasonable to assume that this would take around 12 months, based on other comparable decision-making processes. An application would be expected to draw on the material set out in this and related reports already prepared for TCQ, which should reduce the preparation time needed.

## 16.2 Scheme design

This paper has developed a conceptual congestion pricing scheme design capable of being implemented in Auckland. The next steps are for policy, operational concepts and system design to be developed in more detail, with specific concepts to be taken further for assessment, including technology and civil engineering specifications. The refined requirements and evaluation exercise should include updated demand, traffic, revenue and cost modelling, and an updated social assessment.

## 16.3 Procurement, delivery and operation

There are a wide range of potential approaches to delivering a congestion pricing scheme. Auckland will require an approach that reflects local and national requirements and supports existing legal and institutional arrangements. The delivery approaches available vary depending upon the extent to which the contracting authority wishes to finance, own, operate and manage the elements of the pricing system. Internationally, there are four broad approaches to delivering road pricing systems:

1. **In-house ownership and operation**: the responsible agency procures equipment or a system that it owns and manages, and it operates the scheme. It will typically expect the initial supplier to be contracted to maintain the system for a set period.

2. **In-house ownership, outsourced management and operation**: the responsible agency procures and owns the system, but outsources the maintenance, management and operation to a third party.

3. **Single supplier Public-Private Partnership (PPP)**: the responsible agency contracts the design, delivery and operation (and perhaps finance) of the system to one entity responsible for the provision of pricing services as a concession for a set period of years.

4. **Open system of certified service providers**: the authority develops a series of output-based specifications, allowing a number of suppliers to offer pricing services to users against those specifications. A single contracted supplier is still needed for the necessary on-road infrastructure and associated systems for compliance.

The selection of the procurement, delivery and operating model will affect every aspect of the programme: timetable, capital and operating costs, customer relationships, enforcement, the functions that remain with the roading authority, the system's flexibility and scalability, the level of specificity required for design and contracts, and trade-offs that may need refinement as key policy dimensions of the scheme are finalised. In addition, the initial procurement decision affects not only the initial installation and delivery of the scheme, but also the longer-term operation, costs, modifications or updates to the system. Experience with many overseas toll road operations has highlighted the need for the roading authority to be able to exercise control over the key policy decisions to ensure the holistic management of the local transport network is not undermined[64].

## 16.4 Utilisation of existing systems

As part of the technology assessment[65] undertaken by TCQ, existing infrastructure and technology solutions used by AT and Waka Kotahi were evaluated for applicability, reusability, expandability, scalability and security. The ability to build upon existing infrastructure and systems has significant implications for estimated scheme costs, the required timeline for delivery, and overall project risks.

The methodology adopted for assessing existing systems involved:

- a high-level reference design to determine scope for the assessment
- meetings with key stakeholders
- technical information gathering on existing AT and Waka Kotahi systems
- assessment of information based on expert review and preparation of a technical report.

64 Refer Australian Senate review of toll roads.
65 *Technical Assessment*, TCQ Working Paper (2019)

### 16.4.1 New system elements

The technology assessment found the following new system elements would be required to implement a congestion pricing scheme in Auckland:

- deployment of a new ANPR camera network capable of on-board ANPR decoding
- development of a congestion pricing rules engine to receive ANPR data and make the tariff model operational
- development of congestion pricing back-office systems including an interface to the MVR and operational reporting into customer service, technical operations, finance and enforcement functions
- development of a friendly and easy to use mobile/web app for customer account management.

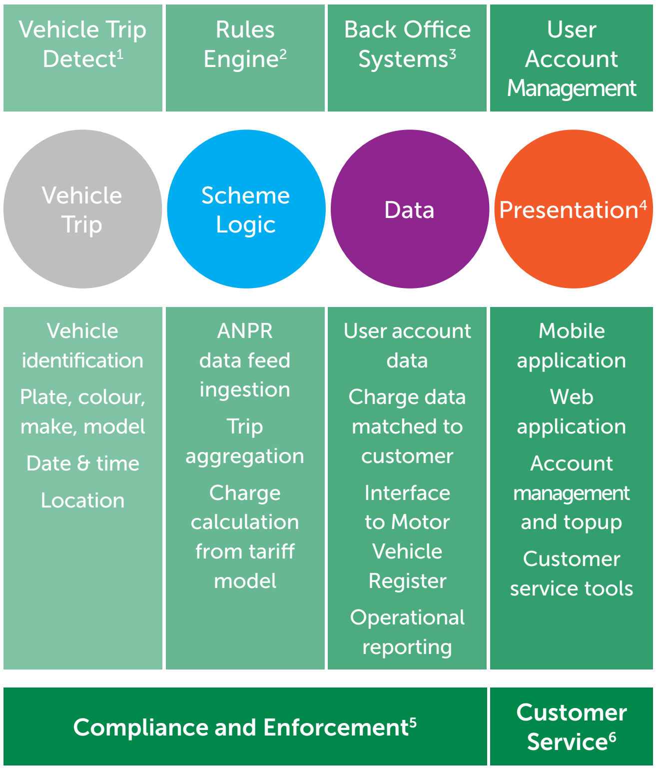
### 16.4.2 Existing system elements

The technology assessment found that the following existing areas within AT and Waka Kotahi could potentially be repurposed to implement a congestion pricing scheme in Auckland:

- existing camera infrastructure such as mounting poles, power, networking and roadside cabinets
- depending on camera location, a small number of the existing AT cameras
- Auckland Transport Operations Centre (ATOC) asset management team for the monitoring, maintenance and tuning of cameras
- AT's new camera installation process to ensure best mounting and configuration of cameras
- existing relationships with networking, closed-circuit television (CCTV) and civil works suppliers
- AT or Waka Kotahi collections systems and processes
- potentially some reuse of the Waka Kotahi toll road web application
- customer service teams within Waka Kotahi or AT, expanded to support a congestion pricing scheme
- adoption of single sign-on credentials across myAT, Waka Kotahi toll roads and a congestion pricing scheme.

Figure 49 summarises the overall congestion pricing system and where new elements are needed, or existing elements could be leveraged.

**FIGURE 49: SUMMARY OF TECHNOLOGY ASSESSMENT MAIN FINDINGS FOR SYSTEM REQUIREMENTS**




Notes:

1. Deploy new edge capable ANPR cameras.
   Reuse existing fixed infrastructure.
2. New rules engine to meet scheme design objectives.
3. New back office systems.
4. New web front end for account management.
   Reuse user data.
   Single login across myAT and TollRoads desirable.
5. Use existing NZTA or AT collections systems and processes.
6. New customer service team or build out NZTA/AT customer service.

*Source: Technology assessment, TCQ Working Paper (2019)*

## 16.5 Demonstrations and pilots

The international review found that only two jurisdictions currently operating congestion pricing schemes conducted some form of pilot or demonstration project[66]. The review concluded that, although not essential, pilots or demonstrations can be helpful for both external and internal reasons. Outwardly, they focus public discourse on something concrete, making the feedback more meaningful and relevant to the final scheme design. Inwardly, they prepare agencies for the challenges of delivery by identifying gaps in competence, systems, or inter-agency linkages. They can also reveal opportunities for technical improvements, such as Stockholm's decision to abandon costly and redundant vehicle tag and beacon technology and utilise ANPR exclusively for vehicle detection.

The success of the overseas trial deployments suggests that a demonstration and/or pilot of the operational concept should be considered for Auckland. The duration of live demonstrations overseas has varied from several months to a year or even longer. In the Auckland context a suitable demonstration or pilot project would be expected to take of the order of 12–18 months for completion following a decision to proceed. The proposed demonstration timetable needs to include the time required for design and communication activities, participant recruitment and training, the live field test, the participant surveys, and the evaluation exercise and final reporting phase[67]. Any demonstration and/or pilot of the operational concept would also require the necessary legislative change to enable congestion pricing.

## 16.6 Public and stakeholder engagement

TCQ recognise that public and stakeholder engagement is a critical element of project success, as understanding and acceptability will be key factors in any subsequent decision to introduce congestion pricing. Prior to a final decision on whether or not to implement congestion pricing, a comprehensive stakeholder and public engagement exercise should be undertaken.

Overseas, lack of public acceptance is a major factor that has halted development of urban congestion pricing schemes. Successful schemes have achieved synergy between policy, design and communications with the public, particularly those most likely to pay the charge.

Auckland travellers and local communities need the opportunity to respond to the provisional scheme design, and potential benefits and costs need to be clearly explained and articulated. Evolution of the scheme is expected to occur over time, as people become more comfortable interacting with the scheme, and the scheme is adapted to better meet its stated objectives.

66 *Review of international pricing initiatives, previous reports and technologies for demand management purposes*, D'Artagnan Consulting (2017)
67 *Demonstration Project*, TCQ Working Paper (2019)

## 16.7 Complementary policy measures

As part of the longlist evaluation, TCQ undertook a preliminary review of four options, shown in Table 31, that were identified for further investigation as complementary measures to a congestion pricing scheme[68].

The analysis found that none of these options represented an effective stand-alone intervention capable of improving network performance in a meaningful way. However, as parking policies and car sharing are already in use, it is useful to review their application to understand if they could be modified or enhanced to further support the outcomes sought by the introduction of a congestion pricing scheme.

The complementary measures considered by TCQ can be considered to be a subset of wider Travel Demand Management (TDM) initiatives. TDM is defined as the application of strategies, policies, plans and initiatives to manage travel demand more enduringly by reducing the need to travel and by distributing trips across travel modes, routes and times. TDM is an aspect of ATAP and features in the Mode Shift Plan for Auckland developed by Auckland Transport and Waka Kotahi.

**TABLE 31: COMPLEMENTARY MEASURES CONSIDERED**

| Option | Evaluation commentary |
|---|---|
| Parking Policy | Changes to parking policies and pricing, such as expanding time restrictions or introducing resident parking schemes, are already utilised by Auckland Transport aimed at discouraging some trips and contributing to demand reduction. Depending on the type of parking policy there may be potential for unintended consequences and significant implementation issues. |
| Car Sharing | Measures focused on increased carpooling, to increase average vehicle occupancy rates, are already in practice and should continue to be promoted, noting that it is unlikely to make a significant impact on network performance. However, it may provide a way to reduce exposure to costs from congestion pricing for motorists. |
| Reverse Tolling | Providing incentive (through payments to road users) to change behaviour would present long-term challenges for sustainability and it raises significant equity issues as the rewards typically go to those that already have travel flexibility. |
| Free Public Transport | Making public transport free would create significant capacity constraints and on-going funding would present long-term challenges for financial sustainability. Targeted reductions to fares (via higher subsidy levels) may have more potential and could be considered further as part of a wider programme to encourage mode shift to public transport. |

68 *Complementary Policy Measures*, TCQ Working Paper (2019)

## 16.8 Scheme revenues

The objective of TCQ is to improve network performance through congestion pricing to manage demand. Raising revenue is not the purpose of the scheme, noting that other forms of taxation are more efficient and less costly to administer if the sole objective is to raise revenue[69]. However, congestion pricing is by its nature a revenue source, as congestion pricing works by exposing road users to a price to achieve behaviour change and reduce the external costs of congestion to society. Transparency on the use of revenue generated is critical. Overseas, how net revenues are used has been shown to be important in getting buy-in from the public for congestion pricing[70] (and can also be a reason to oppose congestion pricing). It is also important to articulate these messages around revenue in the narrative and messaging relating to congestion pricing in any public engagement exercise.

The development and adoption of a revenue policy is an important implementation task. Evidence from overseas suggests that Auckland, subject to practical considerations and the amount raised by the scheme, should consider adopting the following policies towards the use of net revenues raised from the implementation of a congestion pricing scheme:

- Be transparent on how the revenue is used in order to gain public acceptance.
- Reinvest in public transport and other options, including roading improvements, to provide more alternatives to paying the congestion charge, helping to improve network performance and to minimise the financial impact for motorists.
- Fund any redistributions to financially vulnerable households identified as being adversely negatively affected by the scheme. This could involve transfers or reimbursements to those on low incomes who incur the charge (for example, through the Community Services Card or the Working for Families scheme).

There may also be an opportunity to use some of the net revenue to offset the Auckland Regional Fuel Tax.

69 *Social Impacts of Time and Space-Based Road Pricing*, International Transport Forum Roundtable report 30 (November – 1 December 2017)
70 *Review of international road pricing initiatives, previous reports and technologies for demand management purposes*, D'Artagnan Consulting (2017)

# 17 ROLLOUT OPTIONS

The City Centre Cordon and the Strategic Corridors options represent the schemes that TCQ consider to have the most potential, balancing improvements in network performance with practical and equity considerations, noting that relative spatial coverage will be the main determinant of any scheme's impact on improving network performance.

The purpose of this section is to present different rollout options for an Auckland congestion pricing scheme and determine if there is a preferred option at this point. This section presents the benefits and shortcomings of three different rollout options, to highlight considerations around selecting an implementation pathway for a congestion pricing scheme.

The term 'rollout', in the context of this section, refers to the implementation of an operational congestion pricing scheme. Implementation includes procurement and delivery of an ANPR vehicle identification and enforcement network, charge processing and a customer services centre. The options discussed are not necessarily exhaustive, and detailed implementation planning for a congestion pricing scheme may raise additional constraints or options.

## 17.1 Implementation requirements

The City Centre Cordon and the Strategic Corridors schemes have a number of consistent requirements for implementation as outlined in Section 16, regardless of the rollout timetable and approach. Once enabling legislation is in place, where the implementation requirements differ is in the scale of technical infrastructure and back-end services. The larger the scheme (or phase) being implemented, the greater the number of ANPR cameras that will be required. This will increase the resources and time required to:

- physically install and test the network of cameras
- scale systems and technology to process greater volumes of ANPR records securely
- deploy customer services operations to manage customer interactions
- communicate with users of the scheme to ensure that everyone who is likely to use a charged route understands the impact of the scheme on them personally
- prepare materials for decision-making.

## 17.2 Rollout options

Three rollout options were selected for consideration:

1. Implement the City Centre Cordon scheme alone, without further expansion.

2. Phased introduction of the Strategic Corridors scheme with phasing based on selected groups of corridors that are added to over time, depending on traffic conditions and availability of travel alternatives.

3. Implement the Strategic Corridors scheme in its entirety from the outset.

### 17.2.1 Relationship between options

The two preferred congestion pricing schemes are not exclusive – they could either be implemented as stand-alone schemes in their entirety, or in some combined form. The City Centre Cordon scheme can also be viewed as being a subset of the Strategic Corridors scheme. This means that if the Strategic Corridors scheme is selected for implementation, the City Centre Cordon scheme will, by default, virtually be put in place because of the nature of the corridors approaching the city centre.

## 17.3 Main findings

The three rollout options cover a spectrum from geographically small (with relatively lower risks) to geographically large (with relatively higher risks). The smaller the scheme, the more quickly it can be implemented. A phased approach will also enable knowledge gained in early phases to be applied as the scheme expands.

### 17.3.1 City Centre Cordon

A stand-alone City Centre Cordon is simple to understand, represents a modest and straight forward implementation, and is comparable to congestion pricing schemes around the world. This option can be implemented relatively quickly (estimated at two years following a decision to proceed).

There are good alternative modes of transport (to car travel) currently available for travel to and from the city centre, making the introduction of a city centre scheme equitable from an accessibility perspective. In 2019, the proportion of trips made to the city centre by car is now below 50% and continues to decline. This has been matched by strong growth in public transport patronage and cycling numbers on the major routes into the city centre.

The City Centre Cordon represents the low risk implementation option. However, without further expansion, the scheme will generate limited improvements to network performance because of its restricted geographical coverage.

### 17.3.2 Phased Strategic Corridors

The Strategic Corridors scheme is targeted at congested routes and generates meaningful, region-wide network performance improvements. Over time, the phased Strategic Corridors scheme is likely to encompass all motorways, strategic arterials and main arterial routes in Auckland. The selection of Strategic Corridors for inclusion in each phase is proposed to be based on:

- severity of congestion on the corridor(s)
- availability of alternative modes of transport on the corridor(s)
- social and spatial equity considerations
- feedback from stakeholders and scheme users.

A phased approach will also give:

- more time to gain public acceptability and, in the long term, deliver the most credible scheme to solve Auckland's congestion problems
- time to review the impacts of the current scheme before moving to any additional phase
- the chance to observe motorist responses and assess the effectiveness of mitigation measures while progressing through the phases.

Depending on the geographic coverage of the first phase of this rollout option, the scheme is likely to take a minimum of two years to implement the initial stage. Subsequent phases, depending again on geographic coverage of each phase, may take 6–18 months for each rollout.


Potential drawbacks with a phased approach are:

- The risk of diversions may increase with a phased rollout of selected corridors, with the need to consider any parallel routes in order to mitigate or reduce diversions (or rat-running) away from the charged roads.
- Discontent may be generated amongst motorists who use routes first selected for charging.
- Temporary spatial inequities may be introduced because areas of Auckland included in each phase may feel disadvantaged.

### 17.3.3 Comprehensive Strategic Corridors

A comprehensive Strategic Corridors scheme will generate meaningful, region-wide network performance benefits and congestion relief. However, a full Strategic Corridors option has the greatest 'go-live' risk due to the size of the scheme and volumes of transactions that will be generated from day one. This approach will also raise risks around scheme design, the supporting technology platform, and implementation efficiency.

Due to the extensive spatial coverage of the Strategic Corridors scheme, it is anticipated to take up to approximately four years to implement from the time a decision is made. Because the scheme covers a large geographic area, it will require a substantial programme of civil works to build the supporting ANPR camera infrastructure. An extended timeframe would provide for several complementary projects (public transport and walking and cycling network improvements) to be delivered to provide alternatives to driving and paying a congestion charge. A long implementation period means that Auckland's traffic problems are likely to get worse before congestion pricing is introduced as a demand management tool.

### 17.3.4 Preferred rollout option

Based on the main findings, and in particular considerations relating to access to alternative transport choices, TCQ recommends that a staged approach to rolling out the Strategic Corridors scheme is adopted if there is a decision to proceed with the implementation of a congestion pricing scheme.

# 18 ILLUSTRATIVE TIMETABLE

This section presents an illustrative timetable that could be followed if a decision is made to implement a congestion pricing scheme. It presents a phased rollout, as the introduction of corridors will depend on analysis of local traffic conditions and the availability of practical transport alternatives, as well as social and community considerations. The suggested timetable is based on the adopted Auckland RLTP, which outlines the proposed programme of public transport services and infrastructure investment for 2018–2028.

It would be possible to deliver this phase earlier than 2025 if there was a decision to proceed with implementing congestion pricing that was less concerned with linking its introduction to public transport improvements.

## 18.1 Phase One – 2025

Phase One could entail the implementation of the City Centre Cordon by 2025 to coincide with the opening of the City Rail Link (CRL):

1. City Centre Cordon / city centre and fringe extent of the Strategic Corridors

This would be supported by the following network improvements that are already planned and/or committed as part of the RLTP:

- the CRL with new stations at Aotea and Karangahape Rd, supporting additional rail services, reduced rail journey times and increased rail capacity
- city centre bus improvements and ferry basin upgrade
- Northern Busway extension and station upgrades, with improved services and reduced journey times
- several cycleway improvements into and out of the city centre
- AMETI Eastern Busway, with improved services and reduced journey times.

## 18.2 Phase Two – 2028

Phase Two could build on the City Centre Cordon with the addition of the following strategic corridors by 2028:

2. Northern Motorway and parallel corridors to Albany

3. Southern Motorway inside the Auckland isthmus and key corridors

4. Pakuranga Highway and Ti Rakau Drive to Botany

This would be supported by the following network improvements that are already planned and/or committed as part of the RLTP:

- provision of a light rail line connecting Auckland Airport to the city centre
- Third Main (rail) project from Wiri to Westfield, Papakura to Pukekohe rail electrification, and Puhinui Station upgrade, with improved rail services and reduced journey times
- provision of the Northern Pathway (SkyPath and SeaPath) cycle and walkways and the Glen Innes to Tamaki cycle path
- three new rail stations (with supporting park and ride facilities) in Auckland's Southern Growth Area.

## 18.3 Phase Three – Post 2028

Phase Three could build on Phase Two through the addition of the following strategic corridors in the period following 2028:

5. Outer sections of the Northwest Motorway and key corridors towards Westgate

6. Outer sections of the Southern Motorway and key corridors towards Papakura

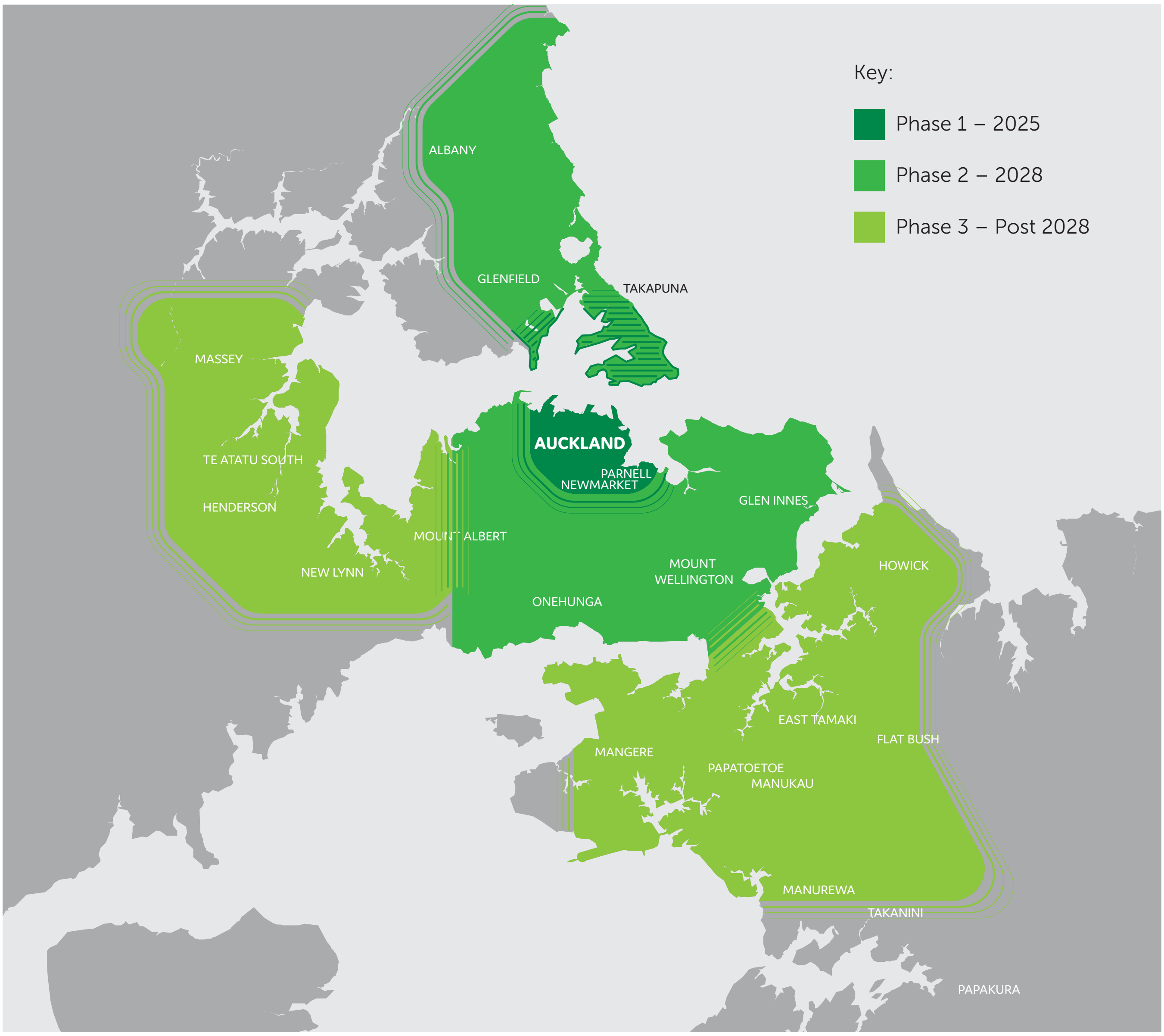
This would be supported by the following network improvements that are currently being considered by Waka Kotahi and AT:

- provision of a light rail line along the Northwest Corridor between Brigham Creek Road and the city centre
- Lincoln Road corridor improvements
- provision of the Waterview to New Lynn cycle path
- provision of additional electric trains, supporting passenger rail capacity and service frequency improvements.

## 18.4 Geographical illustration of phasing

Indicative areas of Auckland that will be included in each phase are shown in Figure 50. Note that the boundaries of each area are only illustrative, and the particular corridors that would be included within each area/phase would be determined and agreed closer to the time of implementation.

## FIGURE 50: INDICATIVE AREAS OF AUCKLAND THAT ARE PROPOSED TO BE INTRODUCED IN EACH PHASE



## 18.5 Review

An initial period of six months is recommended after going live, to review:

- tariff parameters
- charging schedule
- corridor scheme coverage
- phasing timetable.

The review period may be adjusted, and it may be appropriate to move to a shorter or longer review in the future, but undue granularity and excessive changes will raise legitimate concerns and, potentially, public opposition. A formal review process will require the impact on network performance to be evaluated, so consideration will need to be given to developing additional network performance metrics that can be observed before and after implementation to monitor performance.

Part six

# CONCLUSIONS

**This section concludes the report with a discussion of recommendations and next steps.**

19. **Conclusion**: presents the conclusion of the technical investigation.

20. **Next Steps**: discusses next steps for the continuation of the project.

# 19 CONCLUSION

Based on the technical work undertaken in the TCQ investigation, there is a strong case for implementing congestion pricing in Auckland for demand management purposes. However, prior to a final decision on whether or not to implement congestion pricing, TCQ recommends that a comprehensive stakeholder and public engagement exercise should be undertaken.

# 20 NEXT STEPS

The next steps for TCQ would be to re-engage with the key project stakeholders, present them with the main findings and gain feedback. Consideration will also need to be given to the form and timing of wider public engagement and the recommendations made in the initial Mana Whenua assessment.

Auckland travellers and local communities need the opportunity to respond to the provisional scheme design, and potential benefits and costs need to be clearly explained and articulated. TCQ recognises that lack of public acceptance is a major factor that has halted the development of urban congestion pricing schemes overseas. Successful schemes have achieved synergy between policy, design, and communications with the public, particularly those most likely to pay the congestion charges.

A decision to introduce a congestion pricing scheme in Auckland would require legislation. This could be achieved by amending the LTMA, which provides for the government to introduce a road tolling scheme. Alternatively, the government may prefer to introduce new enabling legislation for congestion pricing. It is expected that a legislative process to draft, consult and pass supporting legislation for the purposes of congestion pricing would take approximately 12-18 months once policy decisions have been made.

Decisions will also be required around the proposed ownership and operating model, and the preferred approach to procurement once the final design is developed. Complementary measures, such as additional support for active modes, car-sharing and parking policies, could be introduced to support the ability of motorists to change their travel habits in response to congestion pricing.

Auckland should also consider whether to undertake a demonstration project to build confidence and support public engagement. A demonstration project could also be used for a variety of purposes, including testing technology and testing interfaces between customer service and account management, as well as obtaining feedback on options from participants.

# DEFINITIONS AND ABBREVIATIONS

| Term/ Abbreviation | Definition/Description |
|---|---|
| Active modes | Walking and cycling. |
| AC | Auckland Council. |
| AFC | Auckland Forecasting Centre. |
| ANPR | Automatic Number Plate Recognition. Technology to identify vehicles based on video technology to read their number plates and match that number to a database of vehicle owners. |
| Area-based pricing/charging | Charging vehicles for crossing a geographically defined ring or driving within that ring at specific times of days, typically to manage demand. London's congestion pricing scheme is an area charge scheme. |
| Arterial network | Arterial roads are defined as high capacity local roads that connect suburbs in urban areas and play a critical role in moving people and goods. |
| AT | Auckland Transport. |
| ATAP | Auckland Transport Alignment Project. |
| AT HOP card | An electronic fare payment card for use on public transport services operated by Auckland Transport. |
| ATOC | Auckland Transport Operations Centre. |
| BCR | Benefit cost ratio. |
| Carpooling | A carpool is when two or more people share a car-ride to a similar destination. |
| CBA | Cost benefit analysis. |
| CCTV | Closed-circuit television – a TV system in which signals are not publicly distributed but are monitored, primarily for surveillance and security purposes. |
| Chargeable event | The detection of a vehicle on a road that is subject to a charge at the time when the detection occurs. |
| Congestion | Congestion can be defined in different ways, but generally relates to vehicles travelling at slower speeds than they would otherwise be able to travel due to increased traffic on the roads. |
| Congestion pricing/charging | Charging vehicles for use of specific roads during specific times and days, in order to reduce the severity and duration of congestion on the network. |
| Cordon pricing/ charging | Charging vehicles for crossing a ring or line of charge points across a series of roads at specific times of day, typically to manage demand. Cordon pricing does not charge for traffic movements within the cordon. Stockholm's congestion pricing scheme is a cordon scheme. |
| Corridor-based pricing/charging | Charging vehicles for using specific corridors within a road network. Gothenburg's congestion pricing scheme incorporates some corridor charging. |
| CRL | City Rail Link. A 3.45 km twin-tunnel underground rail link up to 42 metres below the Auckland city centre which will allow the rail network to at least double rail capacity. Due to open in 2024. |
| Demonstration | In the context of road charging, a time-limited live trial or testing of a series of possible policy/ technology options for implementing a road charging system. |
| Distributional impacts | In this context, distributional effects refer to how the impacts of transport projects or interventions vary across different groups within society. |
| DSRC | Dedicated Short Range Communications – also known as tag and beacon road charging, whereby a small battery powered device is installed in a vehicle to enable identification in a toll system. |
| EEM | Economic Evaluation Manual. The EEM sets out economic evaluation procedures and values used in calculating benefits and costs, necessary for applications seeking investment where a benefit cost appraisal from the Transport Agency is mandatory. |

| Term/ Abbreviation | Definition/Description |
|---|---|
| eRUC | Electronic Road User Charging – the electronic system offered by some providers in New Zealand (currently EROAD, Coretex, Teletrac Navman and Picobyte Solutions ) to provide a GNSS platform for road user charging. |
| ERP | Electronic Road Pricing – the congestion pricing system operational in Singapore. (The same terminology is also used for proposals in Hong Kong and Jakarta.) |
| Exemption | Legal exemption from having to pay in a road charging scheme, based on vehicle or vehicle owner characteristics. |
| GDP | Gross Domestic Product - the total monetary or market value of all the finished goods and services produced within a country's borders in a specific time period. As a broad measure of overall domestic production, it functions as a comprehensive scorecard of the country's economic health. |
| GNSS | Global Navigation Satellite System. A generic term for such systems (which includes the USA's GPS, Europe's GALILEO, and Russia's GLONASS). |
| Heavy vehicles | Vehicles 3.5 tonnes and over – typically rigid and articulated trucks and buses, as well as special purpose vehicles such as cranes. |
| HOT lane | High Occupancy Toll lane. A highway lane that is exclusively for use of buses and high occupancy (ie more than X passengers) vehicles, or for single occupancy vehicles if they pay a toll. |
| HOV lane | High Occupancy Vehicle lane. An HOV (also known as a carpool lane, diamond lane, 2+ lane, and transit lane or T2 or T3 lanes) is a restricted traffic lane reserved for the exclusive use of vehicles with a driver and one or more passengers, including carpools, vanpools, and transit buses. |
| HTS | Household Travel Survey. An ongoing survey of people throughout New Zealand, conducted by the Ministry of Transport which collects information about day-to-day travel. |
| Hypothecation | The process of assigning or ring-fencing revenues (typically tax) for a specific purpose, or in certain cases, ensuring they are not spent on a particular purpose. This is in contrast with general government expenditure from a consolidated fund. |
| ITF | International Transport Forum. The International Transport Forum at the OECD is an intergovernmental organisation with 60 member countries. It acts as a think tank for transport policy and organises the Annual Summit of transport ministers. ITF is the only global body that covers all transport modes. The ITF is administratively integrated with the OECD, yet politically autonomous. |
| Journey window | A period of time within which one, or more journeys may be made. |
| LBA | Local Board Area. |
| Light vehicles | Light vehicles, with a total weight of less than 3.5 tonnes, include cars, motorcycles, mopeds, vans, people-movers, and trailers. |
| LoS | Level of Service. |
| Mode share | Proportion of travel undertaken using a certain transport mode. |
| MSM | The Auckland Macro Strategic Model. |
| MVR | Motor Vehicle Register. Records information about vehicles used on New Zealand roads and the persons responsible for their use. |
| Network-based charging | Charging all vehicles on a road network (varying by time, location and vehicle type) typically by some form of metering of distance or time spent on the network. |
| $NO_x$ | Oxides of nitrogen, especially as atmospheric pollutants. |
| NPV | Net Present Value. |

| Term/ Abbreviation | Definition/Description |
|---|---|
| NZIER | New Zealand Institute of Economic Research. |
| OBU | On-board Unit. |
| OCR | Optical character recognition. |
| PCU | Passenger car unit – a vehicle unit used for expressing road capacity. |
| Pilot | A live trial of the proposed policy/technology option as an initial small-scale implementation of a road pricing system. A pilot may or may not be time limited and may or may not be limited by number of participants. |
| $PM_{10}$, $PM_{2.5}$ | Particulate matter 10 micrometres or less, 2.5 micrometres or less (respectively) in diameter. Particles can be of any substance and, in these size ranges, make up a large proportion of dust and pollutants that can be drawn deep into the lungs. |
| PPP | Public Private Partnership. PPPs involve collaboration between a government agency and a private-sector company that can be used to finance, build, and operate projects, such as public transportation networks, parks, and convention centres. |
| PT | Public transport. |
| PV | Present Value. |
| RFT | Regional Fuel Tax. The Auckland regional fuel tax scheme began on 1 July 2018, at a rate of 10 cents per litre (plus GST), on petrol, diesel and their bio-variants. This tax supports transport projects that would otherwise be delayed or not funded. |
| RLTP | Regional Land Transport Plan. |
| Road charging | Direct charging of road users for the use of the road network, distinct from tolls in that charging is not applied to a single part of the network to recover the infrastructure costs for that part of the network. |
| Severe congestion | In this report, severe congestion is defined where the volume to capacity ratio is 0.8 or greater – which equates to stop-start traffic and significant delay. |
| TCQ | The Congestion Question. The name of the technical investigation project to consider whether there is a case for introducing a congestion pricing scheme for Auckland. |
| TDM | Travel Demand Management. |
| Tolls | Direct user charges in the form of regulated, facility-based tolls for usage of specific road corridors. |
| Toll lane | One or more lanes on a highway that may only be accessed by paying a toll, typically physically segregated from other un-tolled lanes. |
| VKT | Vehicle kilometres travelled. |
| VOC | Volatile Organic Compounds – organic (carbon containing) chemicals that have a high vapour pressure at ordinary room temperature. Some VOCs are dangerous to human health or cause harm to the environment. |
| Waka Kotahi | Waka Kotahi New Zealand Transport Agency. |
| WoF/CoF | Warrant of Fitness / Certificate of Fitness. The periodic safety inspection that all vehicles must undergo. |

# ANNEX: OPTIONS REFINEMENT

With the selection of the City Centre Cordon and Strategic Corridors options as the preferred schemes to be taken forward from the shortlist options for further investigation, TCQ had the opportunity to undertake additional scheme refinement for the purposes of the next round of options evaluation. This Annex outlines the spatial changes that were made to the preferred schemes to improve their predicted performance against TCQ's evaluation criteria.

## City Centre Cordon

The City Centre Cordon is effectively defined by the boundary of SH1 and SH16. Vehicles are charged when they cross this boundary indicated by the solid black line in Figure 51. To improve the predicted network performance, the design of the cordon was refined to include additional cordon charging points:

- Shelly Beach Road (AM)
- Curran Street (PM).

In addition to those changes, to resolve diversion onto Newton Road (caused by trips that would normally use Wellington and Union Streets to access SH1 southbound), the cordon was further refined to remove the charge for this movement.

**FIGURE 51: CITY CENTRE CORDON**

## Strategic Corridors

An analysis of the detailed traffic patterns generated from the transport modelling undertaken for the shortlist evaluation also revealed some issues stemming from the original spatial design underpinning the Strategic Corridors scheme. In particular:

- Long trips were incurring excessively high charges due to the extent of the charge applied by road hierarchy (eg north of Silverdale, south of Papakura).
- Distinction in road classifications along parallel roads causes diversion and does not improve overall network performance.

To resolve these issues the spatial charge coverage was refined as follows:

- Only apply charge to areas experiencing congestion.
- Remove charges outside the urban area.
- Add charges in more locations within the urban area.
- Address modelled diversions by adding/removing charges on potential parallel alternatives.

The revised coverage of the Strategic Corridors scheme is shown in Figure 52. It should be noted that this definition was for the purposes of the next round of transport modelling and evaluation, and is therefore not necessarily representative of an implementation deployment.

**FIGURE 52: AUCKLAND REGION**


**Key:**

— Roads included in the modelled Strategic Corridors scheme

Auckland Council
Te Kaunihera o Tāmaki Makaurau

WAKA KOTAHI
NZ TRANSPORT AGENCY

Ministry of Transport
TE MANATŪ WAKA

THE TREASURY
Kaitohutohu Kaupapa Rawa

STATE SERVICES COMMISSION
Te Komihana O Ngā Tari Kāwanatanga

New Zealand Government