

Review of ATAP methodology and evidence

Advice from the Independent Advisor



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Client: Auckland Council

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Quality information

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Executive summary

This report has been prepared by AECOM New Zealand Ltd (AECOM) which was appointed as the independent advisor to the Auckland Transport Alignment Project (ATAP). It presents the third iteration of a review of ATAP processes, evidence collection and evaluation. The first, second and third iterations of this report were submitted to ATAP in May, July and August 2016 respectively. This version describes the progress, evidence and risks for ATAP as of 7 September 2016.

The purpose of this review process is to report to the ATAP Governance Group on the rigour employed by the ATAP team in its research and evaluation of the evidence that supports the development of an optimal package of policies and projects. This package will define a strategy for the future investment in transport infrastructure and transport policy. The optimal package will also provide a comparator with the Auckland Plan Transport Network (APTN) to demonstrate improved outcomes/efficiency.

This report therefore seeks to provide the Governance Group with confidence that ATAP has adopted best practice in its work. It provides, where appropriate, reference to and comparison with the methodology/practice and outcomes employed in other geographies seeking to develop similar investment plans.

Conclusions

The Independent Advisor's review of ATAP's work has concluded:

- The methodology used within ATAP has identified a well-considered final indicative package of transport interventions that respond to forecast future transport challenges.
- The final indicative package of infrastructure proposals is acceptably optimised given the information currently available and the ATAP schedule.
- Further optimisation of the final indicative package is recommended as the designs for its infrastructure components are developed.
- The work undertaken and the conclusions reached by ATAP were NOT biased by earlier planning or infrastructure plans. The ATAP work can be considered as "fresh thinking".
- The methodology and research work undertaken followed a systematic and logical approach.
- The ART model data used in the value for money assessment of intervention packages is only suitable for comparison of similar sized packages. Further more detailed work will be required to assess programme level and individual project benefit cost ratios.

Recommendations

The Independent Advisor's recommendations of the ATAP's work to 7 September 2016 can be summarised as:

- A risk and mitigation register is established to record both package specific and common risks and to manage mitigation needs.
- ATAP should develop an "assumptions book" that documents the assumptions made that support the ATAP recommendations and analysis.
- The decision to exclude the CBD cordon pricing demand management option from round three of the package refinement limited ATAP's understanding of options for the use of pricing as a means of demand management.
- A high level programme of ATAP interventions should be developed for the first decade and this programme should include legal, policy, change requirements. In relation to infrastructure interventions the programme should indicate key dates to initiate approvals and procurement activities for projects to be delivered in the first decade and for ALL major projects (value greater than \$1bn).
- To improve confidence in the outcomes of changes to transport technology and the impacts of pricing to manage demand, further modelling work will be required after the conclusion of ATAP and a strategic model be developed that can better reflect perceived changes in the cost of travel and ride sharing.
- For the ATAP agencies to have confidence in the likely impacts of the use of smarter transport pricing to manage demand and to better understand the impacts of changing technology, improved strategic modelling tools are needed. The development of such tools may take in excess of a year. Any tool

developed for this purpose will need to provide a range of functionality not currently provided by the ART model. Ideally the research necessary to develop such a model should take place for this before the next census and the planned updating of the ART model in 2018.

- That the road components of the renewals operation and maintenance paper is updated to reflect how the ATAP agencies will respond to how the Auditor General's feedback on maintenance and renewals is to be actioned.
- That where BCR's are documented that were produced using ART model data caveats should be provided, making clear that they are provided as comparators only and business cases will be produced to verify the value for money of individual projects / interventions.
- In the next 12 to 18 months, indicative business cases be developed for the key interventions that deliver the majority of benefits in the second and third decades of ATAP. This will mitigate the uncertainty in BCR's that arise from the current limited levels of project development of the preferred investment programme.
- A resilience review of key transport infrastructure is undertaken shortly after the completion of the final ATAP deliverable to determine if any additions or alterations are necessary to the ATAP recommendations to mitigate network resilience risk.
- The ATAP agencies continue to pursue post ATAP means mutually agreeing an approach to balancing the needs of Arterial road performance and amenity. Such an agreement is a precursor to establishing a forward programme that would deliver highly cost effective improved outcomes.

1.0 Introduction

1.1 Purpose

This report has been prepared by AECOM New Zealand Ltd (AECOM) which was appointed as the independent advisor to the Auckland Transport Alignment Project (ATAP). It presents the third iteration of a review of ATAP processes, evidence collection and evaluation. The first, second and third iterations of this report were submitted to ATAP in May, July and August 2016 respectively. This version describes the progress, evidence and risks for ATAP as of 7 September 2016.

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This report therefore seeks to provide the Governance Group with confidence that ATAP has adopted best practice in its work. It provides, where appropriate, reference to and comparison with the methodology/practice and outcomes employed in other geographies seeking to develop similar investment plans.

1.2 Version Control

This report (Issue E- 7 September 2016) provides an overview of the methodology and evidence developed by ATAP to support its strategic approach and its final infrastructure proposals.

It reflects the ATAP work completed at 7 September 2016. The report will be updated once more when all ATAP research papers and reports are complete. It provides comment upon the manner in which the methodology has been applied and the extent to which the conclusions drawn by ATAP are drawn from new evidence and thinking that develops through to the final report "Recommended Strategic Approach" (August 2016) and supporting information in mid-September 2016

Comment is offered on the likely confidence the ATAP agencies may have in the findings and the management of identified risks.

1.3 ATAP Project methodology overview

The ATAP project methodology is defined within the group's terms of reference. The methodology was developed and supported by senior officers from the ATAP Government agencies and AECOM as the ATAP independent advisor. Aspects of the methodology are discussed in more detail in following sections.

The methodology comprised a logical series of processes designed to develop a knowledge base of the existing performance of the Auckland transport network. It also used existing transport modelling tools and a range of documented assumptions to forecast future transport demand and network performance to reflect population increases and changes to employment patterns.

These forecast changes were based upon projections from Statistics NZ, Auckland Council and Auckland Transport and reflect the expected location and timing of growth in newly urbanised areas (as outlined in the Future Urban Land Supply Strategy). The employment location assumptions have been independently reviewed by the New Zealand Institute of Economic Research (NZIER) in a paper titled 'Auckland employment over the next 30 years' dated March 2016.

ATAP objectives and Network performance

The performance of the transport network is described through the use of performance metrics that reflect the ATAP objectives of:

- Improving accessibility to employment and labour.
- Improving congestion results.
- Improving public transport mode share.
- Ensuring net benefits to transport users from increased financial costs.

Suitable metrics/performance indicators were agreed between the Government agencies participating in ATAP. The current and future forecast transport network performance and chosen metrics formed the basis of a deficiency analysis.

A deficiency analysis was undertaken by forecasting the future performance of Auckland's transport network with projected population/employment changes and then comparing how well the network performed in comparison with the agreed ATAP metrics.

Changes to the forecast future performance of Auckland's transport network were modelled to reflect different packages of alternative investment strategies and a range of transport infrastructure and/or demand management measures. A preferred package describing a strategic direction and a small number of future scenarios reflecting varying population/employment changes and level and types of investment were tested.

Forecasting changes to transport networks' performance over long periods, based upon assumptions regarding variations in population, employment, technology and of people's trip and mode choices, carries significant risk of error. Usual practice to mitigate these risks is to recognise that as the timeframe of forecasts increases, so too does the risk of error.

Forecasts beyond 10 years are often based upon differing scenarios that seek to understand likely performance based upon a range of values of forecasting inputs. For example, ATAP has considered scenarios of 'medium' and 'high' growth of population and employment, and both 'expected' and 'high' rates of technology uptake and impact.

Intervention packages

Three alternative transport investments were developed as 'packages' that enabled comparison with the Auckland Plan Transport Network (APTN). These 'packages' were considered more as providing differing strategic intent rather than a finalised list of projects for implementation. (See section 3.0 below.)

The content of the intervention 'packages' was subject to development and optimisation through four rounds of refinement as noted in section 3.0 below. The process sought to determine an 'optimal' final package that provides the best mix of benefit within likely transport investment budget taking elements from each of the development packages.

The 'packages' were used to test differing transport investment strategies. The performances of each alternative strategy were evaluated against the ATAP performance indicators and the deficiency analysis, to understand how they compared in terms of value for money and achieving the ATAP objectives. Their performance was compared to the APTN, a high investment package (focused on addressing capacity constraints), an influencing demand package and a base network. The base network comprised committed projects, minor local road projects, the eastern airport access (SH20B), the Transport for Urban Growth (TFUG) programme, excluding new major connectors and projects over \$200M, the walking and cycling programme and the Rail Development programme.

The ATAP analysis is founded upon a range of assumptions in relation to population, land use, adoption of new technologies etc. The more significant of these assumptions have been discussed with the ATAP Steering or Governance Groups. AECOM recommends that ATAP should develop and maintain an assumptions book that documents the assumptions made throughout the 'package' development and testing process.

2.0 Commentary of the ATAP approach

2.1 Strengths

There is much to commend in the ATAP approach outlined in Section 1. It is logical, evidence based and seeks to understand the cumulative impacts of alternative packages of transport investments.

The use of modelling tools to assess the likely future performance of differing packages differentiates this approach from methodologies used by many other jurisdictions in Australasia, Europe and the Americas. It has been diligently applied such that the approach adopted should be considered to be robust and provide strong insight into likely future transport needs and infrastructure performance (subject to the inherent inaccuracy in making assumptions relating to long timeframes).

Whilst the use of modelling tools can and should be seen as a strength of the methodology, it also creates risk in terms of the suitability of the tools used and variances in purpose that the tools were created to serve. The suitability of the Auckland Regional Transport (ART) model has been separately reviewed in an ATAP research paper. This paper concluded that the use of the ART model was suitable to be used by ATAP with caveats limiting its use to that of determining relative performance of packages, rather than absolute performance.

Attempts to find other examples of the development of infrastructure investment planning where modelling has been used to form the basis of the programme creation have so far found only a few examples. Those found include the development of a long term motorway strategy, a Long Term Transport Master Plan (both in New South Wales, Australia), and Infrastructure Australia's Infrastructure Plan.

2.2 Constraints

The four largest constraints on ATAP and the execution of the methodology described above were:

- Availability of staff.
- Availability of modelling resource.
- Delivery schedule.
- The current level of engineering development of many of the interventions being considered.

These constraints are briefly discussed below.

Availability of core ATAP staff

The core ATAP team comprised staff from five Government agencies. These staff were only available to work part-time on ATAP. The core team was led by a full-time Project Director with support from JMAC, a small number of specialists and AECOM as independent advisor. Progress on research, formulation of appropriate transport infrastructure packages and their testing through modelling was constrained by availability of personnel and testing and option development needed to be limited.

Availability of modelling resource

ATAP is using a methodology that requires a large modelling input and is being supported by JMAC. The independent advisor's lead representative has spoken with senior staff from JMAC and it is clear that it is highly skilled with an excellent knowledge of the ART model, its limitations, and also many of the potential infrastructure projects under consideration. However, it is also evident that the relatively small size of the JMAC team constrains the support it can provide to ATAP (and indeed other non ATAP projects). ATAP has modelled more than 170 different transport interventions, reporting on the cumulative impacts of multiple packages, with each package subject to a range of differing population and technology scenarios.

JMAC contracted modelling capability from consultants to help mitigate the capacity constraint as far as possible given availability of personnel with appropriate skills in the market. Even with this support, a lack of modelling resource at times delayed progress and limited option testing.

Delivery schedule

The schedule to complete ATAP in less than twelve months was very ambitious given the magnitude of the task to be undertaken. The independent advisor has sought to identify similar scopes of work from other geographies that have also used strategic modelling to inform a planned infrastructure investment programme. Very few have been found but those identified in ii) above sought to report on a far more limited analysis.

A brief synopsis of each instance is provided below:

- i. *The NSW Long Term Transport Master Plan (LTTMP) used a large (20 plus) full-time team for analysis and documentation. This project was scheduled for more than an 18 month delivery programme. The modelling work undertaken was fairly limited and provided only a short overview of a forecast future deficiency in transport network performance. The cumulative impacts of the list of projects that comprise the LTTMP were not determined nor was the selection of the chosen projects optimised for performance and budget.*
- ii. *The Sydney Motorway Strategy sought to produce a high level implementation strategy of a limited number of motorway projects surrounding Sydney and also to identify gaps in the motorway network. A full-time team believed to be circa 15 staff took more than 6 months to produce this strategy. It has not been published.*
- iii. *Infrastructure Australia (IA) has recently published its Infrastructure Plan. This includes an analysis that has taken approximately 36 months to undertake. It provides a forecast future deficiency analysis for each Australian State capital and is based upon strategic modelling. The Infrastructure Plan includes the formulation of an investment strategy and priorities to meet the determined deficiency.*

Given the above constraints and the experience of other examples of similar studies, the delivery of ATAP to the planned schedule was ambitious. The limitations of modelling resource and time available meant that the number of potential investment packages considered was limited to just three, and included just two rounds of optimisation. These limitations prevented a more varied formulation of investment packages to be developed and tested or a broader range of scenarios to be considered.

Engineering development of interventions

During more detailed assessment of the interventions being considered by ATAP during the development of cost estimates, it became apparent that many of the projects have had little or no engineering development. As a consequence there is an increased risk that the intervention may prove unfeasible due to engineering, geotechnical or environmental matters. (See sections 3.6, 6.1, and 6.3 below.)

3.0 ATAP Intervention package development process

The time and resource constraints described above limited the ATAP intervention package development process. The following sections describe the four round process adopted to respond to these constraints. This is followed by a brief commentary on how well the process performed in overcoming the constraints and how this may affect confidence in the final package outcomes.

3.1 Round 1: Understanding intervention impacts

This round sought to develop an understanding of the regional impacts of a large number of potential infrastructure investments. Its purpose was to gain insight into what the likely impacts of individual projects would be with respect to the performance metrics aligned to ATAP objectives. The rationale of this work was to identify and to reject those investments that would provide poor returns, i.e. have limited impact for their size/cost.

The methodology for this round of analysis involved defining approximately 50 medium to large scale (cost) interventions. These interventions were then grouped into four model run 'tests'. Two groups included mode specific capacity increases, one test included public transport investments and the last test included major transport projects. The outputs from these four tests were then assessed to determine, as far as was feasibly possible, individual intervention impacts.

Clearly testing multiple interventions in a single model run and then seeking to understand each individual intervention's unique contribution is a less than ideal approach, but was adopted due to the limitations of time and modelling capacity.

Another impact of time constraint relates to the time available to spend optimising the potential benefits of the Common Elements Enhanced Base (CEE) against which the ATAP package performance was compared. The work undertaken in Round 2 process excluded interventions that ART indicated offered a poor return on investment. This analysis included very limited consideration on how the impact of these measures might be optimised. AECOM recommends that if the ATAP schedule permits, further optimisation of the third iteration of the Common Elements Enhanced (CEE3) is undertaken. As stated above, many of the Common Elements are likely to be implemented in the first decade. As part of the optimisation of CEE, a priority investment programme for the first decade should be developed to outline level and be sufficient to inform the planning and timing of the approvals and procurement process.

3.2 Round 2: Establishing logical investment in three themes

This round of package development created three themed packages of infrastructure investment / policy interventions. The performance of these packages was then tested to determine their effectiveness at responding to the ATAP objectives and the needs described by the earlier deficiency analysis. It used the forecast future performance of the Auckland Plan Transport Network (APTN) and its associated expenditure as a comparator benchmark. This approach of limiting investment packages to the cost of the APTN was adopted to constrain the number and cost of themed interventions so as to produce a meaningful comparison of performance.

The comparison between each package theme helped to establish the relative performance of each package. The themed packages were designed to achieve value for money, be internally consistent, and be likely to deliver discernible changes in transport network performance. Interventions within each themed package were structured to be consistent with the themes' objectives.

The round 2 package development methodology was as follows:

- Establish a baseline for comparison using existing commitments, and a selection of projects necessary for an effective test of the themes.
- Estimate themed expenditure using the APTN cost cap, baseline costs, and the APTN maintenance operations and renewals costs.
- Structure interventions along each package theme.

3.2.1 Theme 1 Constraint focus (also called 'Providing Supply' in early testing)

This tested the impact of providing interventions that addressed forecast transport network capacity constraints that resulted in poor levels of service. The package prioritised interventions that addressed the most severe

forecast capacity constraints on the road and public transport networks, particularly in areas and on parts of the networks that will service the greatest numbers of users.

The prioritisation process used was to:

- Identify and rank network performance issues by severity (volume to capacity ratio) and consequence (volume); and
- Prioritise interventions that address the forecast deficiencies by providing increased capacity where there are network performance issues.

3.2.2 Theme 2 Influencing demand

This tested the impact of network wide road pricing, plus appropriate interventions where network levels of service required them. This package prioritised interventions that would best complement a network-wide road pricing system by providing sufficient transport choices so that the benefits of a pricing scheme can be maximised, the dis-benefits minimised and over-investment avoided. The prioritisation process used was to:

- Identify and rank network performance issues by proximity to employment areas or areas with deficient access to employment.
- Prioritise interventions that address transport network performance deficiencies by providing alternatives (choices) that were not resolved with road pricing in place.
- Consider ways to discourage movements that conflict with access to and from areas with poor employment access.
- Consider public transport interventions where congestion impacts upon employment access.

It was noted that it is likely that changes to legislation and potentially the taxation system will be required for the introduction of smarter transport pricing as a means of influencing demand. As a consequence the lead time for influencing demand measures can be large. Should the final ATAP package recommend a smarter transport pricing package, then the consequence of this long lead time will need to be understood.

AECOM has noted that ATAP did not carry the CBD cordon pricing option forward to Round three of the package refinement due to time constraints. Given that this pricing approach is one of the less complex means of pricing road use and offers an opportunity of a staged implementation of wider network charging, this decision has limited ATAP's understanding of implementation options for the use of pricing.

3.2.3 Theme 3 Employment centre focus

This tested the impacts of improved access to and between major employment centres. The package prioritised interventions that improved access to current and future major centres of employment (including the central area). The different characteristics and constraints of major employment areas were recognised in this process.

The prioritisation process used was as follows:

- Use of the deficiency analysis and round 1 model outputs, review employment accessibility for commuters and accessibility to employment centres to establish the highest priority areas for investment.
- Use of the round 1 evaluation results to prioritise interventions which improved access for regional areas with lowest employment accessibility.
- Prioritised interventions that increased the speed or capacity of existing movements on radial routes and to / from / between sub-regional employment centres.
- Implemented interventions appropriate for the employment centre they support.

The forecast future network performance of each of the above themes was assessed compared with the forecast performance of the APTN. This provided an understanding of how the above themes responded to the deficiencies identified earlier and provided an initial understanding of cost efficiency.

3.3 Round 3: Package refinement and optimisation

During this round of package development the most promising two packages from Round two were compared to the APTN and a base investment package comprising: committed projects, TfUG schemes under \$200m, the eastern airport access, minor local road schemes, the rail development programme and the walking and cycling

programme. This comparison used the ART model to assess the four packages performance in meeting the ATAP objectives.

The two most promising packages used in this comparison were:

- An influencing demand – designed to broadly reflect the emerging strategic approach outlined in the second ATAP deliverable. This package included a network-wide road pricing system (but at a lower price than earlier analysis, see section 5.1.3) and supporting infrastructure and services. It is very closely aligned to the indicative final investment package.
- A higher investment package based upon a modified constraint focus theme but with a substantial increase in the level of investment to determine if a step-change in performance could be achieved. The estimated cost of this package was approximately 36% greater than the APTN and 25% higher than the influencing demand package.

The output from this comparison showed that:

- The influencing demand theme achieved superior performance to the other packages.
- A much increased investment in infrastructure designed to add capacity in locations where congestion is forecast performed second best and only marginally better than the APTN for most ATAP objectives.
- The APTN showed some improvement over the base package but this was typically limited to the third decade of the investment programme.

Whilst there is risk associated with the use of the ART model because it was not developed to test road pricing and does not respond to differing values that people place upon time (i.e. their willingness to pay a charge for reduced travel time). The step change in performance compared to other investment packages strongly suggests that measures that influence travel choice and the demand for road capacity provide the best outcomes and value for money.

3.4 Round 4: Optimising intervention timing

This round of package development sought to optimise the timing of interventions of the influencing demand package. It used the knowledge gained from rounds two and three to refine the package content and to produce a better response to the challenges identified by the deficiency analysis and improve performance against ATAP KPI's.

An investment prioritisation framework was developed that incorporated:

- Alignment with ATAP objectives.
- The evaluation intervention benefits.
- Estimated cost.
- Consistency with Strategic direction established during round two of package development.

The application of the framework to projects with an estimated cost greater than \$200 million, produced an intervention prioritisation matrix. This matrix axis reflects an interventions potential to maximise value for money and its ability to deliver ATAP performance objectives.

This round of package development is complex and alignment has not yet been reached between all representatives of the ATAP Working Group. Further work on understanding the benefit cost ratio for a programme comprising the measures included in final indicative package is progressing.

The intervention prioritisation matrix is shown in Figure 1 below,

Figure 1: The intervention prioritisation matrix

		Potential to deliver value for money in first decade		
		High	Medium	Low
Extent to which investment targets most significant first decade challenges	High	Highest priority to be progressed in the first decade	Secondary priority to be progressed in the first decade	Unlikely to be first decade priority
	Medium	Secondary priority to be progressed in the first decade	Unlikely to be first decade priority	Not a first decade priority
	Low	Unlikely to be first decade priority	Not a first decade priority	Not a first decade priority

The use of this matrix based approach and its application to the first decade's interventions is a sensible and pragmatic means of selecting interventions for early implementation. Conclusion of the Benefit Cost Ratio work currently in hand will be required before the recommendations for the first decade can be finalised.

3.5 Commentary on package development process and response to constraints

Having considered the above constraints and the methodologies developed and implemented, we have concluded that the processes ATAP adopted were appropriate responses to the constraints placed upon it. This has resulted in the successful delivery of the Recommended Strategic Approach in August 2016 (with, the supporting information, due in mid-September 2016).

The work undertaken by ATAP is founded upon data that it developed collaboratively within the ATAP agencies through the use of strategic modelling and evaluation of its outputs, original research commissioned by ATAP and reference to published papers. AECOM considers that the work undertaken and the conclusions reached by ATAP were NOT biased by earlier planning or infrastructure plans. The ATAP work can be considered as "fresh thinking".

3.6 Package development and assessment of value for money assessment

The ATAP Working Group has considered the value for money of interventions contained in the recommended final indicative package. Some members of the Working Group have rightly raised concern at offering BCR values for the recommended interventions. This matter has also been discussed with members of the ATAP Steering Group and Governance Group.

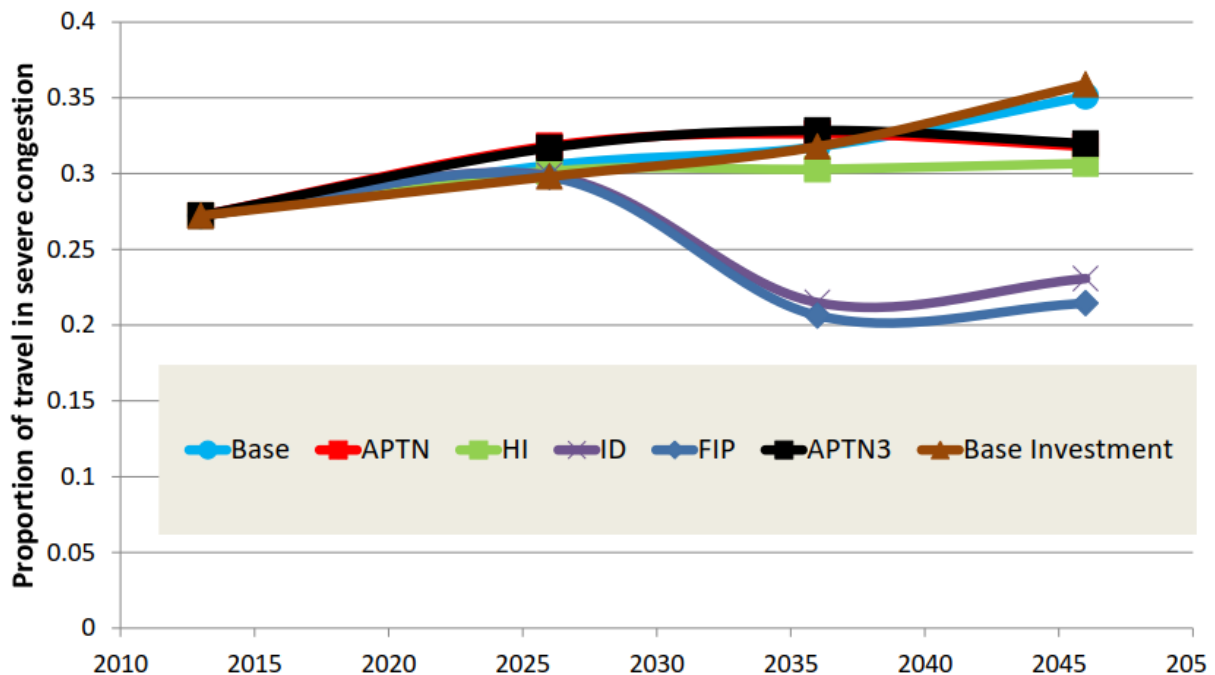
The primary reason for concern is the precision with which the costs and benefits of interventions can be estimated. (See sections 6.1 and 6.2.) Given the limited development of most of the interventions being considered by ATAP, uncertainty relating to both costs and benefits, this is understandable. However, the ATAP Working Group has taken reasonable steps to recognise these limitations. It has also been noted by the Working Group that the majority of benefits estimation has relied heavily upon the use of the ART model. A review of the suitability of this model (see section 5.1.2) concluded that it was reasonable to draw comparisons of benefits between two competing packages of interventions or competing projects of similar size, but should not use the absolute values of benefit for business case development for specific projects (e.g. changes in travel time savings or vehicle operating costs).

AECOM believes that it reasonable for ATAP to base package selection and refinement decisions on the comparative BCR's produced by the work done to date. However, caveats should be provided wherever these comparative BCR's are documented, making clear that they are provided as comparators only and confirmation of project specific business cases will be produced to verify the value for money of individual projects / interventions.

The value for money assessment undertaken during the development of the final indicative package has focused upon how well the 'packages' have performed against the ATAP objectives and included examining changes to average trip durations and time spent in severe congestion, both of which are strongly related to travel time savings. When undertaking detailed benefits assessment of new transport infrastructure as part of the development of a BCR, travel time saving usually accounts for a substantial proportion of all benefits (typically in the range 50% - 70%).

During the package development process four differing packages were considered. Figure 2 below shows the relative performance of the 'packages' evaluated in both rounds 3 and 4.

Figure 2 Proportion of car travel time spent in Severe in the AM Peak



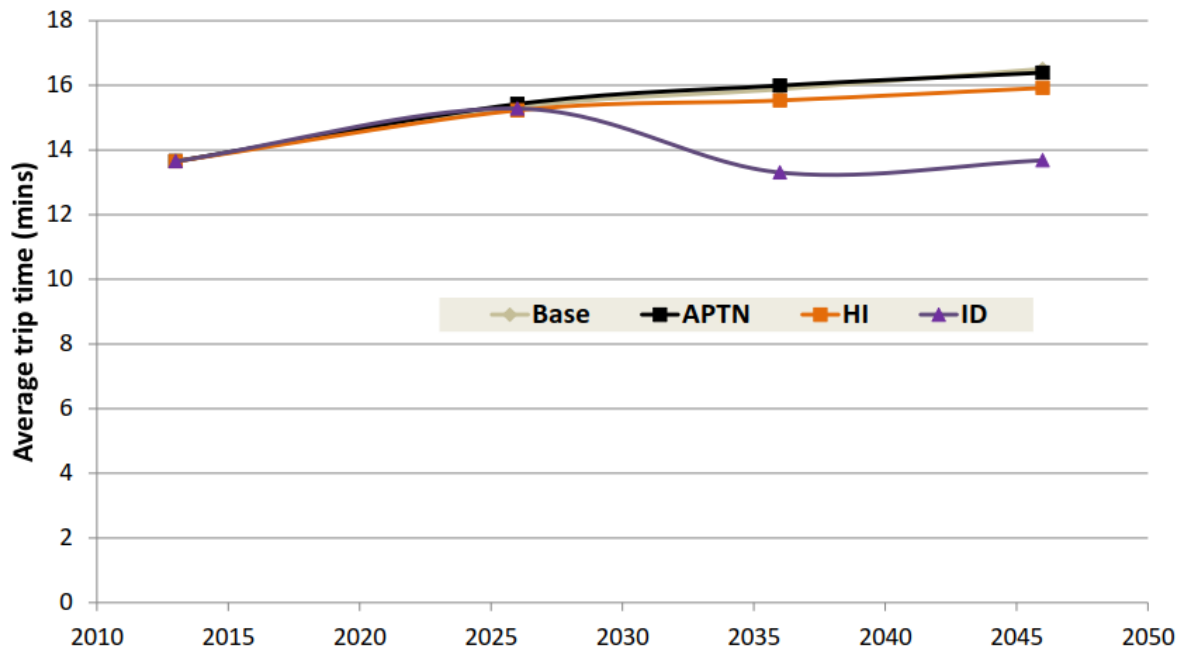
As can be seen the Influencing Demand (ID) and the Final Indicative Package (FIP) show a step change improvement in congestion results. The relative cost of the packages is as follows:

- High Investment (HI) \$40.7 billion
- Final Indicative Package \$37.6 billion
- Influencing Demand (ID) \$33.2 billion
- APTN \$29.8 billion
- Base Investment (CEE3) \$19.2 billion
- Base (CEE4) \$18.7 billion

The final indicative package is very similar to the ID package. Its principal difference is the inclusion of the second Waitemata Harbour Crossing and associated motorway connections increasing its cost.

Figure 3 below is based upon the round 3 'package' development stage. It again shows a step change in travel time and shows a step change in performance between influencing demand and the APTN and a high spending strategy.

Figure 3 Average Trip Time, Car Users AM Peak



The data from figures 2 and 3 strongly indicates that the Influencing Demand (ID) and the Final Indicative Package (FIP) offer greater benefits and comparative BCR than the APTN and also a high investment strategy. The ATAP Governance Group can have confidence that the FIP offers a better outcome than other 'packages' considered in respect of congestion, and travel time.

The BCR for the final indicative package is being developed by Richard Paling Consulting Ltd and is being subject to an external peer review by Ernst and Young. AECOM has not yet seen any documentation regarding the methodology or assumptions used in the BCR assessment or the results of the peer review. AECOM cannot yet provide any comment on the BCR. AECOM would recommend that any BCR produced using ART model outputs should be subject to caveats described above.

3.7 Eastern Strategic Corridor assessment

AECOM in its role as the independent advisor to ATAP was tasked by the Governance Group to undertake a preliminary assessment of the Eastern Strategic corridor as proposed by the NZ Council for Infrastructure Development (NZCID). The scope of this assessment was to compare road alignments options in the Eastern Strategic corridor against other infrastructure investments included within the "providing supply" network wide package. The assessment was to consider, at high level, the operational and economic performance of the options and "providing supply" package (now called constraint focus) using data provided by Joint Modelling Application Centre (JMAC) sourced through the Auckland Regional Transport (ART) model.

Two alignment options were considered. The first option was an "at grade" expressway following the eastern corridor alignment described by NZCID and connecting back to the local road network at Highbrook Drive. The second eastern corridor alignment comprised a motorway following the same alignment but extending further south to Murphys Road. Common to both of these options is the assumption of an eastern alignment of the Additional Waitemata Harbour Crossing (AWHC) with the southern portal connecting into State Highway 16 (SH16) in Grafton Gully.

The performance of these alignment options was evaluated against the defined ATAP objectives, including an indicative assessment of value for money.

When compared against the “providing supply” package, both eastern options decrease travel time in the AM peak for trips in the south and south-east of Auckland. Freight travel times also decrease from the Ports of Auckland to the industrial hubs in the south. Furthermore, the motorway option is more attractive than the expressway and thereby draws traffic off State Highway 1 reducing congestion in the Manukau area. However, when compared against the whole network, congestion only decreases by 1% for the motorway option.

AECOM estimated the construction cost (excluding cost of property acquisition) of the expressway option to be \$10.89bn and the motorway option \$11.26bn, a difference of \$370m. A 5.5km tunnel from Panmure to Highbrook Drive is the largest item of construction expenditure (excluding the new harbour crossing) and accounts for over 25% of both options cost.

Preliminary Benefit Cost Ratios (BCR)'s for both options as modelled present poor value for money when compared to the “Providing Supply” package. The BCR for the expressway is approximately 0.2 and the BCR for the motorway approximately 0.4. This means that the Nett Present Value (NPV) of benefits does not outweigh the investment costs.

Based on the findings of this investigation and our understanding of the benefits evaluation of other measures being considered by ATAP, AECOM recommends no further consideration of a road alignment in the Eastern Strategic corridor within the current ATAP project. However, we also recommend that corridor protection for the alignment should be maintained until such time as the ATAP Government agencies commit to both the additional western alignment of AWHC and the use of the smarter transport pricing approach being developed within ATAP.

4.0 Final ATAP deliverable

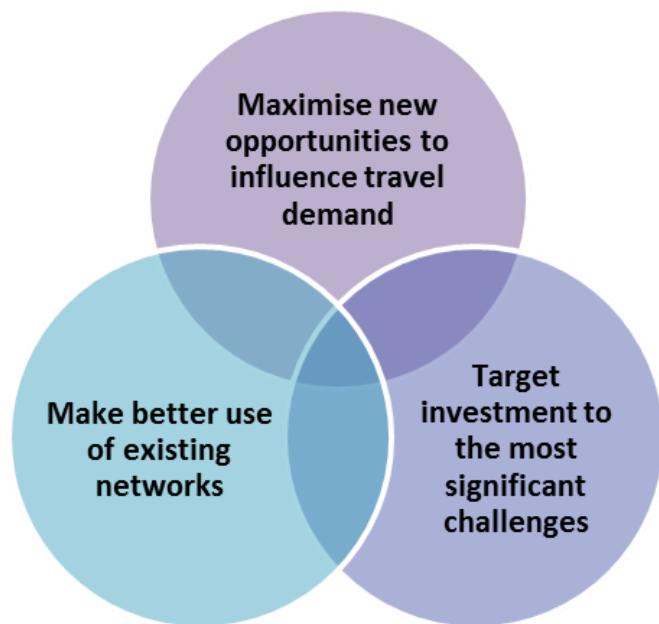
The final ATAP report “Recommended Strategic Approach” (August 2016) has been considered by the Steering and Governance Groups and has been submitted for consideration to the ATAP Parties comprising:

- The Minister of Transport
- The Minister of Finance
- The Mayor of Auckland
- Auckland Councillor Bill Cashmore

This report clearly describes a recommended strategic approach and best performing package from the ATAP investigations. A second document, containing supporting information will be delivered in mid-September 2016.

The Strategic Approach described in the final ATAP Report “Recommended Strategic Approach” (August 2016) contains three integrated elements:

1. Making better use of existing networks by optimising key routes to improve productivity, improve asset management and seeking to maximise the benefits from new transport technologies.
2. Maximise new opportunities to influence travel choices and demand by better integration of land use and transport decisions, encouraging increases in vehicle occupancy and move to smarter transport pricing.
3. Targeting investment to address the most significant transport challenges by prioritising investments to achieve best value, strengthen the strategic networks and enable and support economic growth.



5.0 Supporting evidence and research papers

AECOM has reviewed much of the evidence produced by ATAP as described below. [Note: AECOM has provided input into the preparation of papers below, namely Technology; ART Model; Costing; Freight.]

5.1 Research papers

ATAP has developed a number of research papers that have supported its work. The purpose of these papers varies: some seek to establish a range of likely future impact of some aspect of potential infrastructure change; others seek to inform future demand, infrastructure costs and revenue. Each has highlighted risks, some of which can be mitigated to an extent by ATAP; other risks will require action beyond the ATAP programme. AECOM recommends that a register of the risks to the future transport network highlighted through ATAP needs to be established.

These papers cover a diverse range of subject matter briefly described below:

5.1.1 Transport Technology

The Technology paper focuses on the potential impacts of technological change on the transport task and impacts on transport network performance. The information in the paper has been drawn from a large range of sources including the use of the ART model. (See section 5.1.2 regarding the ART model below.) The ART model uses fixed demand matrices and consequently does not include induced traffic. It does not therefore reflect that the number of trips may change significantly if web based car sharing were to become far more widespread or

autonomous vehicles were to be used in substantial numbers. The change to journey time benefits outlined in the technology paper may therefore be over or understated.

The research has highlighted that “connected vehicle” technologies could potentially have a significant impact on the need for infrastructure investment. To encourage the adoption of this type of technology in private vehicles, the Government agencies have a range of potential legislative and policy levers that they might wish to consider. Further work will be required to understand better what these levers are and the lag between their use and significant adoption of the technology in the New Zealand vehicle fleet. To achieve the high level of adoption required to yield meaningful increases in capacity within the second ATAP decade will most likely require Government agency intervention in the first decade.

AECOM recommends that a high level programme of ATAP interventions be produced early within the first decade. This programme should include legal, policy, approvals, procurement and infrastructure interventions.

5.1.2 ART Model

The purpose of this paper was to provide comment upon the suitability of the ART model to support ATAP. A number of conclusions were reached. The most significant are:

- ATAP needs a multimodal transport model to evaluate options for the future and ART3 is the only model in Auckland which has the capability.
- The ART model’s suitability to be used to test alternative transport projects is dependent upon what purpose its outputs are to be used for. Many of the agreed ATAP performance metrics are based upon journey time data which is a metric that regional models are not typically used to derive, nor are they usually well calibrated/validated for. However, since much of the work of ATAP is seeking to compare the performance of two similar sized intervention packages and in such circumstances the ART model is a suitable tool to produce comparative data. If comparative differences are small, the ART model outputs should not be used as a point of differentiation.
- The ART model is a strategic model developed to test policies and is not suitable to inform detailed design decisions, to develop bus service plans or to develop individual/detail project business cases.

The ART model has been used to test the impacts of demand management / pricing and increased vehicle occupancy driven by technology change. The ART model was designed for tolling/road pricing as a policy tool but not for detailed economic, equity assessments which require more detailed socio-economic segmentations. Therefore its use in more detailed assessment of travel behaviours is compromised. In particular the ART model uses fixed person trip rates, and this limitation means that it is not well suited to modelling car sharing behaviours or price based demand management.

For a strategic model to better reflect such changes in behaviours, it would need to be able to:

- Use a traffic assignment process that recognises that different sections of the community will have differing Values of Travel Times Savings (VTTS). These differences will affect their sensitivity to differing levels of charge and upon their route and mode choice.
- Reflect variable trip rates that exhibit sensitivity to changes in travel costs including pricing
- Include vehicle classes that reflect High Occupancy Vehicles (HOV) and taxi/ car sharing behaviours.
- Represent trip tours.

To obtain an improved understanding of future network performance, either a new strategic model will need to be developed or future versions of the ART will need to address the above matters.

AECOM recommends that the ATAP agencies seek to produce a model better suited to responding to changing transport technologies and better represent changes in travel behaviour arising from smarter transport pricing. Ideally the research necessary to develop such a model should take place for this before the next census and the planned updating of the ART model in 2018.

Since the preparation of the paper AECOM has been advised that JMAC is progressing the development of a model better suited for testing the ATAP FIP.

5.1.3 Smarter transport pricing

The impacts of smarter transport pricing as a means of making transport costs more transparent to users and influencing demand in the Auckland region have been examined for ATAP. The impacts of smarter transport

pricing on the performance of the transport network has been reviewed using the ART model. As described above, the ART model is currently the best tool available to ATAP to assess the impacts of pricing. However ATAP recognises that the model was NOT developed to research the demand impacts of road pricing and therefore does not reflect the varying values placed upon travel time savings by differing segments of the community.

The paper considered three alternative pricing options, a CBD cordon scheme, motorway network charge and a comprehensive network charge. The impact on the performance of the road network was assessed for each option using the ART model **prior to** round 2 of the package development process.

This assessment showed:

- This option applied a \$10 AM peak inbound charge and a \$2.50 inter-peak and PM peak inbound charge (2015\$'s). It had the least impact on regional accessibility, network performance and modal share. The small impact is to be expected due to the small geographical coverage of a CBD scheme. Several of the results were positive, including reductions in AM and inter-peak travel in congested conditions, improved access to jobs and increased public transport mode share.
- The motorway charge comprised a \$5 AM/PM peak charge for a whole trip and a \$1.25 inter-peak charge. The scheme covered the whole motorway network. It had a greater positive impact on regional accessibility and congestion indicators compared with CBD charging, although the impact on modal share is similar to the CBD charge. The negative effects on local roads, arising as a consequence of trips diverting from the motorway network to avoid being charged, were significant.
- The whole of network charging scheme comprised a \$0.44 per km charge for the AM & PM peak hours and a \$0.12 per km charge inter-peak. (In subsequent ATAP package development a much lower charge was assumed per kilometre as described below.) It had a substantially more positive impact on regional accessibility (measured in terms of travel times) congestion and modal split, particularly in the peak and for public transport (although with the charges road users would face substantially increased total travel costs). This option showed increased numbers of short distance trips by car, although this effect was more than counterbalanced by reduction in longer distance car travel and some shift to public transport. This resulted in a substantial reduction in the total numbers of trips made in the AM peak with some travellers diverted to other time periods.

A basic economic evaluation of the three options was undertaken in accordance with the NZTA's Economic Evaluation Manual (EEM) which concluded that the Cordon charge had the highest BCR at 2.1, the motorway charging scheme had a BCR of 1.3 and the whole of network charge a BCR of 1.6.

The paper concluded:

- That pricing does have the potential to manage demand and improve network performance, compared to the un-priced ATPN. This is in line with theoretical expectations, previous research carried out in Auckland and practical experience in other countries.
- That based on the generally positive results observed, but noting the issues raised, it is recommended that ATAP continue with the assessment of pricing for demand management. It is recommended that the next stage focuses on the development and refinement of a road pricing option that is suitable for the approaches to transport that are to be tested in the second round.
- The investigation is also expected to develop a view on whether pricing for demand management could reduce the level of investment required in the network to achieve a given level of performance, relative to the ATPN.
- That it is likely that pricing for demand management could reduce the level of investment required in the network to achieve a given level of performance. Results supported the view that pricing for demand management provides an opportunity to move towards planning and providing additional transport capacity required to meet a planned level of traffic demand.

As indicated above, subsequent to the production of this paper the whole of network charge was taken forward to ATAP package development. During package development a pricing structure that reflects urban, outer urban and rural roads and motorways was applied for peak, inter-peak and night time. Prices per km ranged from \$0.25/km to \$0.025.

Changes in road user behaviour arising from any form of direct charge is complex and traffic models are typically developed specifically to inform design and planning work. Best international practice for such modelling includes the use of surveyed Value of Travel Time Saving (VTTS) data and segmentation of trip matrices to reflect how different sections of the road user community value their time and equivalent monetary benefit they place on journey time saving. It would not be possible to develop such a model within the schedule of ATAP and therefore the decision to use the ART is reasonable. It should however be noted that this decision carries with it risk and AECOM would recommend that should the ATAP agencies pursue a strategic direction that involves some form of price based demand management, a model is built specifically for the purpose of understanding driver behaviour under a range of tolling strategies.

5.1.4 Freight

Auckland's congestion currently has and is forecast to continue to have a negative impact on the movement of freight within and through the Auckland region. While both Auckland Transport (AT) and NZTA have monitoring programmes for their networks, there is no specific monitoring of freight. The lack of maintained representative data relating to freight movement and efficiency severely limits AT's and NZTA's ability to plan for or improve the performance of freight movements. Ownership of the freight function is shared across multiple parts of NZTA and AT with limited specific budget allocated for improving freight efficiency.

It is also evident that no assessment has been completed to determine if rail can accommodate the projected growth in the freight task on existing infrastructure and how this might change as demand for passenger rail increases. With growing demand for both freight and passenger transit it is likely that there will be a need to separate rail freight and transit, or expect freight to transfer from rail to road. The lack of freight data and a road and rail freight model hinders the determination of the date at which this separation / change of mode is required. A major driver will be the completion of the City Rail Link, expected in 2023, which will allow more passenger trains to operate on the network.

KiwiRail has recently expressed its concern at the growing conflict between providing both transit and freight rail on what is largely a single transit/freight network.

5.1.5 Arterial roads

Arterial roads are a vital part of Auckland's transport network and face a major challenge in coping with the city's projected population growth. Two of the biggest transport challenges facing Auckland are how to balance the different demands placed on roads and streets by different groups of users, and how to balance the local access and 'place-making' needs of roads and centres located on them against the strategic purpose of some roads.

Auckland is not unique in having such challenges and indeed seeking new ways to meet them. Several states in Australia are putting increased emphasis on reducing congestion. Various Auditor General reports have been published that have reviewed the effectiveness of Australian State road authorities. Some consistent themes for improvement can be seen in these reports such as; the need to have clear ownership of the issue, organisational structures, performance measurement regimes and funding aligned to achieving network performance improvements. However, such matters are outside the terms of reference of ATAP.

This ATAP paper proved to elicit divergent options from the ATAP agencies. As such no clear agreement on interventions to improve productivity and reduce congestion was reached. Overall, while this workstream did identify ways in which arterial road productivity could be improved, there are other pressures on the corridors which will limit vehicle productivity and the ability to keep up with expected growth in travel demand.

The paper has identified past experience in network optimisation and the large BCR that such work achieves. The lack of a forward programme for network optimisation for arterial roads has meant that the very significant benefits that usually accrue from such investment have not been identified in the ATAP FIP.

AECOM would recommend that ATAP agencies continue to pursue post ATAP means mutually agreeing an approach to balancing the needs of Arterial road performance and amenity. Such an agreement is a precursor to establishing a forward programme that would deliver highly cost effective improved outcomes.

5.1.6 Revenue & expenditure

This paper sought to investigate a concern expressed by Auckland Council that there was a funding gap of \$12 billion across the next 30 years (around \$8 billion in 2016 dollars) between planned transport expenditure (i.e. the Auckland Plan Transport Network, (APTN)) and its budget allocation for transport as per the Council's Long Term Plan (LTP). The purpose of the ATAP paper was to:

- examine assumptions and calculations of the original funding gap, and
- determine what the gap would be under the various revenue and expenditure scenarios being considered by ATAP.

The Council's concern is based upon an earlier study by the Independent Advisory Board (IAB) into the cost and funding of the APTN.

The size of any gap in funding depends on the assumptions made about Council allocation of funds, (referred to as 'revenue'), to transport over the thirty years and the cost of the package of projects that is expected to be carried out (referred to as 'expenditure'). As noted in the paper "On the revenue side it considered two alternative scenarios to that considered by the IAB. On the expenditure side, ATAP has considered a number of different kinds of packages.

For revenue estimates the paper considered what budget allocation to transport is likely over 30 years to provide an indication of likely future affordability, two scenarios were considered in addition to the assumptions made by the IAB:

- a. Population scenario: the current level of expenditure increased in line with population growth, and
- b. Regional GDP scenario the current level of expenditure increased in line with growth in the regional economy.

ATAP considers the latter scenario to be the most realistic, it being consistent with historical trends and because it seems reasonable to assume that the rating base can deliver revenue in line with the growth in the regional economy. The Treasury projects 1.5% p.a. real growth in per capita GDP for New Zealand as a whole, so this figure combined with the Department of Statistics's medium population growth projections for Auckland were used to calculate projected revenue

A number of differing expenditure profiles were considered but for the purposes of this review of methodology and evidence the most pertinent being the final indicative package.

The table below shows the funding gap derived from the above assumptions on revenue for the final indicative package and assumes the proportion of National government support to Auckland's transport related investment remains at historic levels.

Un-inflated \$billions (a negative number is a funding gap, a positive number a surplus)	Years 2019-2028	Years 2029-2038	Years 2039-2048	Years 2019-2048
IAB assumption scenario				
Final indicative package	(4.06)	(6.59)	(7.18)	(17.82)
'Population' scenario				
Final indicative package	(0.91)	(1.47)	(2.16)	(4.53)
'GDP' scenario				
Final indicative package	(0.04)	1.47	3.61	5.04

As can be seen from the table, the existence and size of the funding gap within any decade varies considerable between the 3 revenue scenarios (assumptions).

The ATAP Parties, and the organisations they represent, will need to consider how to fund transport infrastructure after the publication of the ATAP final deliverable. AECOM believe that the Working Group used a pragmatic and evidenced based approach to examine the assumptions and calculations that were the basis of the concern regarding a funding gap, and what value this might be under a likely revenue and expenditure scenarios.

5.1.7 Rail network development

A slide pack entitled the Auckland Rail Development Programme (ARDP) prepared by Auckland Transport and Kiwi Rail for ATAP and has been reviewed by AECOM. This slide pack sets out recent developments in the rail network surrounding Auckland and provides an update of existing Rail Development Implementation Pathway (2014) and presents an agreed, prioritised programme of investment based on defined service levels.

The slide pack sets out a number of assumptions in regard to the completion of infrastructure under construction (CRL), service patterns, and freight demand. This information provided is noted as being interim outputs and subject to further work.

The slide pack provides an extensive breakdown of planned investment and indicative funding requirement in each of three decades.

The first decade assumes that rail patronage will grow from 15.4 million passengers per year to approximately 30 million passengers per year. This growth rate appears to be consistent with recent rail patronage growth trends (e.g. growth from 10 million passengers per year in 2013 to 15.4 million passengers per year in 2016). The most significant investment enabler of this passenger increase is the CRL with its services becoming operational in March 2023.

The second and third decades are dealt with in a similar vein listing programmed investments and assumptions about patronage and service levels.

AECOM notes that the slide pack does not provide any detail on targeted service reliability or levels of train crowding. It also indicates that patronage is expected to increase from 30 million p.a. 50 million p.a. during the second decade.

The principal risk to ATAP associated with the ARDP is its ability of transit rail to accommodate significant road to rail transfer arising from smarter transport pricing early in the second decade.

Other risks associated with the ARDP but not addressed in the slide pack are:

- Funding and governance of infrastructure development beyond CRL.
- Timing of investments and associated disruption to existing services.
- Delivering adequate service levels given the rapid growth in patronage.
- Accommodation of significant road to rail transfer arising from smarter transport pricing early in the second decade.

5.1.8 Renewals Operations and Maintenance (ROM)

AECOM has reviewed version 3 of this paper dated May 2016. The document presents the forecast cost of operations, maintenance and renewals for both NZTA and AT for the period 2018 to 2048. This information is based upon four principal inputs:

- The Auckland Transport Renewals Optimisation Model.
- NZTA Highways and Network Operations group 30 year M&O forecast.
- The Auckland Transport Consequential Opex Model.
- Auckland Transport's Public Transport Operations 30 year forecast.

The focus of the paper is AT assets (being approximately seven times greater than NZTA assets) and considers roads, footpaths, cycleways, bridges, culverts, rail stations (and associated stabling and depots), electric & diesel trains, busway stations, ferry wharfs, ITS assets, drainage, signs, street lights and tunnels.

The report notes that time constraints have limited the analysis and that the document is subject to further revision. It also notes the difficulty in predicting precisely when a pavement asset will need renewing, and decisions will continue to be made on the basis of condition monitoring.

The paper gives a good account of how growth in the asset base as well as its use will affect ROM costs. The paper considers a number of ROM investment profiles including:

- a. A "cost efficient" profile (the workstream's recommended ROM investment profile)
- b. A "base case" profile (assumes renewals occurs just before failure)
- c. The ATAP profile in package development
- d. The 2015 Asset Management Plan (AMP)

e. The Long Term Plan (LTP) 2012 – 2022.

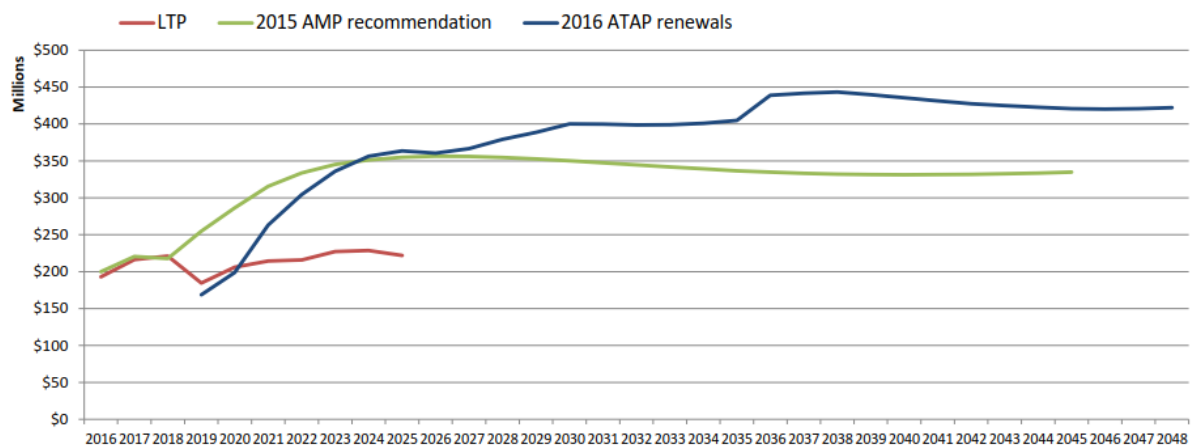
The paper also considers how investment profiles “a” and “b” would affect road pavement condition.

The ROM workstream’s recommended “cost efficient” investment profile provides for greatly increased spending in ROM when compared to the LTP (over \$100m p.a. more in 2023 and 2024). It also envisages addressing a renewals backlog that has arisen in the past.

The recommended “cost efficient” profile is slightly different to that currently envisaged by ATAP. This difference amounts to approximately \$70m increase in 2019 with this difference rapidly decreasing over the following three years. The ATAP ROM profile then increases above the recommended “cost efficient” profile from 2023 primarily due to an increased size of the asset base from delivery to ATAP package implementation.

The primary risk highlighted by the paper relates to the very substantial increase in expenditure from the ROM envisaged budget by ATAP and also the 2015 AMP as illustrated in Figure 4 below. (See also section 6.1, Risk management – cost estimation below.)

Figure 4 Renewals budgets



6.0 Risk management

The methodology adopted by ATAP and research papers commissioned have systematically developed information and informed its review of the optimal transport investment strategy and associated infrastructure and policy choices. Such processes identify risk and where possible mitigation measures. AECOM recommends that a register of risks associated with the final indicative package is developed and mitigation measures are identified.

As part of AECOM’s review of the ATAP methodology and evidence, a number of areas of risk and opportunity for the ATAP agencies have become evident. These are described below.

6.1 Cost estimation

Project cost estimates are required to agglomerate package costs for value for money testing.

Two papers that inform infrastructure costs have been prepared from a range of data sources. These cost estimates and associated contingency allowances will need to be refined as infrastructure designs develop. The cost estimates can be considered as being in two separate streams of work.

The first stream examines capital and design costs. ATAP has developed cost estimates based on either information from project development teams or based upon costs of similar infrastructure.

The construction cost estimation work to date has noted that since the development of the APTN there have been refinements to their estimates and indeed their scope for common elements and enhanced base interventions. Some costs are significantly greater than earlier estimates. It has also been noted that Transport for Urban Growth (TFUG) projects show increases in cost, scope and timing when compared to earlier work.

Independent review of the current cost estimates has been undertaken and only minor changes have been noted.

The principal cause of risk in construction cost estimation is the lack of project development for the majority of interventions being considered. Infrastructure projects are normally subject to significant concept development

and design refinement. These processes are informed by studies into areas of uncertainty such as ground conditions, environmental conditions, and constructability. Design development is also usually supported by value engineering studies seeking to maintain performance but lower costs. Designs having been refined by these processes are then subject to the application of probabilistic cost estimation using a risk based approach to inform estimation and provide contingency. Few of the ATAP interventions planned for the first decade have benefited from the full application of these processes. It is highly unlikely that any of the interventions planned for the second and third decades are at a stage where this optimisation could commence.

The best means of mitigating the risk of significant cost estimation error impacting on the value for money of the final indicative package is that ALL projects to be implemented will be subject to a staged business case process. It is understood that this means of mitigation is to be implemented and the staged business case process requires the above optimisation processes are used and that each project will be required to provide an acceptable BCR before any decision on its implementation can be made.

The second paper considers long term Renewals Operations and Maintenance (ROM) costs. The ATAP research paper on ROM shows that these costs exceed \$50 billion over the next 30 years. This paper has been subject to an expert peer review process and the review concluded that the basis for the cost estimation is reasonable. It highlighted the significant increase in spending that is being recommended when compared to current levels.

AECOM has noted that the paper does not comment upon the Auditor General's recommendations from recent investigation and reporting which make recommendations to improve value for money. AECOM recommends that the ROM paper is updated to reflect how the Auditor General's feedback is to be actioned.

AECOM also recommends that careful consideration needs to be given to how expected efficiency savings might be achieved arising from improved strategic asset management practice. The current estimate of efficiency improvement is assumed to be 0.25% per annum. This figure seems very low based upon literature reviews of best practice. Further work beyond the ATAP programme will be required to realise this opportunity.

The principal risk identified from the review of the ROM paper is that the recommended maintenance and renewal costs are significantly higher than currently funded.

6.2 Benefits Estimation

The majority of information in relation to benefits of the intervention packages (and constituent projects) has been derived from the ART model. However the quality of model output is only suitable for making comparisons between differing packages or competing projects of similar scale.

A number of limitations of this model are noted in section 5.1.2 but given that no better model is available to ATAP to use in developing a strategic intent and an indicative package of investment, therefore use of the ART model is pragmatic and reasonable. Documentation that describes BCR values derived from the ART model should be appropriately caveated to reflect the limitations of the ART model.

It was noted in the modelling research paper that NZTA offers guidance on the suitability of differing model types to derive a range of data. The use of regional models such as the ART model is considered to be only "partially suitable for economic evaluation. Typically project specific models that are subject to more rigorous calibration and validation standards are developed to test large infrastructure changes.

Typically journey time saving represent approximately 50% – 70% of total benefits of road infrastructure improvements. Therefore a model's ability to accurately and reliably reflect journey times is a key requirement for economic evaluations. The research paper on the suitability of the use of the ART model to inform ATAP noted the following:

"The ART model's journey time representation is poor during the AM and PM peaks. It is therefore NOT suitable to inform benefits associated with travel time saving, or business cases" and

"The ART models suitability to be used to test alternative transport projects is dependent upon what purpose its outputs are to be used for. Given the number of agreed ATAP performance metrics that based upon journey time data, my view is that the ART model can only be used to produce comparative data between one project/intervention with another. If such comparative differences are small, ATAP outputs should not be used as a point of differentiation".

It was noted that the BCR for "packages" of interventions derived from the ART model were lower than expected, given that the BCR for many the individual projects were significantly higher. To better understand the likely causes for this were investigated. The transport benefits for a major road project derived from the ART model and a demand model developed specifically for the project were compared. This comparison showed that the project

model suggested a level of benefit some three times that from the ART model. It should be noted that this comparison related to just one project and the differences may vary from project to project, its finding do support an hypothesis that the ART models limitations result in conservative benefits estimations for the model.

6.3 Project feasibility

During the development, assessment and cost estimation, it has been noted that the majority of projects being assessed for delivery in the second and third decades of the programme were at a very early stage of development. Few projects benefited from concept refinement and the usual feasibility studies (e.g. geotechnical, social and environmental). This presents the risk that some projects may not prove to be feasible or that site constraints materially impact on their value for money.

To mitigate that these project risks do not undermine the strategic direction recommended by ATAP, AECOM recommends further investigation and indicative business cases need to be developed for those projects / interventions that deliver the majority of the ATAP benefits.

6.4 Network resilience and reliance on key assets

The resilience of the Auckland transport network can be defined as its ability “to withstand disruption, absorb disturbance, act effectively in a crisis, adapt to changing conditions”.

ATAP’s FIP needs to be considered within the context of the New Zealand’s National Infrastructure Plan (NIP). The NIP has a vision that ‘by 2030, New Zealand’s infrastructure is resilient and coordinated and contributes to economic growth and increased quality of life’.

The NIP States that:

“government will work with infrastructure providers to improve network resilience. Both physical and system resilience are crucial. This means:

- *Organisations and networks of organisations with the ability to identify hazards must share information, assess vulnerabilities, and plan for and respond to emergencies.*
- *Acknowledging the value of adaptability and redundancy in the network to improve business confidence.”*

Much of the focus of the NIP relating to improving transport resilience is in ensuring that network planning takes into account changes in population. Given the rapidly increasing population in Auckland, and its associated transport demand, this is highly pertinent to ATAP.

The work of ATAP defining a strategic direction is based upon an extensive examination of how changing population and employment distribution will affect transport demand and network performance. This should therefore be considered as a key strength of the ATAP analysis. Should the ATAP recommendations be adopted and the FIP implemented over a period of three decades, significant extra new infrastructure will be created to manage network performance and provide improved service. However the FIP will also include increasing capacity of other part of the network which may result in increased reliance on some transport assets. Should the availability of these assets be lost, the disruption to the movement of people and goods could be significant.

The ATAP Terms of Reference (ToR) and objectives omit any direct reference to resilience, i.e. the implications of the FIP upon resilience weren’t an explicit requirement and the constrained schedule for the delivery of ATAP limited any specific resilience assessment either in its current state or with the working Group’s recommendations implemented. There is therefore limited commentary specifically regarding resilience in the final deliverable. Given that a significant proportion of New Zealand’s productivity is reliant on a small number of transport assets such as; State Highway 1, other road links between the Airport and CBD, the Waitematā Harbour Crossing and links to the Port, a review of the implications of the FIP on reliance and resilience would seem prudent.

AECOM therefore recommends a review of the implications of the FIP upon the resilience of the reliance placed upon key transport assets (described above) is undertaken after the completion of the final ATAP deliverable. The scope of this review should be to determine what actions, if any, are necessary to improve their future resilience.

6.5 Transport revenue estimates

A paper is being developed that describes the assumptions being used to assess likely future transport infrastructure revenue. The purpose of this paper is to enable ATAP to determine the nature, scale and timing of

any funding 'gap' between expected revenues and the expenditure necessary to deliver the preferred strategic approach. A brief synopsis of the paper and its content is provided in section 5.1.6.

The key risks identified by the paper for the 'affordability' of the ATAP FIP are:

- GDP and population growing in-line with government forecasts
- Williness of the government agencies to continue to increase their contributions to transport revenue in-line with per Capita growth in GDP
- The accuracy of the cost estimations for the infrastructure investments in the FIP (see section 6.1)

6.6 Population and employment forecasts

Forecasts of population and employment growth and their distribution patterns are key drivers of transport demand, and as a consequence have significant impact upon the transport challenges. The NZIER paper referred to above in section 1.3 noted:

"We assess forecasts of the scale and share of overall employment of "business services" employment to 2046 as plausible. But to the extent we see scope for stronger growth in total employment in Auckland, this should flow through to stronger growth in the scale of Auckland business services employment, "

And,

"The forecast increase in density of employment in Auckland's greater CBD is similar to the experience of Australian cities between 2006 and 2011. Both Brisbane and Canberra added over 4,000 employees per square kilometre. Auckland is forecast to grow at a similar rate from 2016 to 2021. The density forecasts for this wider CBD area therefore seem plausible, but as highlighted in Section 4.1 there is scope for some of this increase in density to be spread further out from the core CBD areas."

Evaluation of the consequences of potential stronger growth than the currently adopted central case of population and employment has been subject to use scenario testing to mitigate risk to infrastructure package design.

A paper was submitted to the ATAP Governance Group on 27 April highlighting the potential for significant difference between the land-use scenario used in ATAP modelling and those proposed in the Auckland Unitary Plan. It was agreed that to manage this risk ATAP deliverable needs to identify the land use assumptions that affect packages.

AECOM consider that the ATAP Working Group both identified the risk and took appropriate action to seek advice from the Governance Group and also mitigate its consequences

6.7 CBD congestion and network integration

The Auckland CBD currently exhibits significant congestion during the AM and PM peak travel hours. A key objective of ATAP is to improve congestion results. Population and employment forecasts indicate that more commute trips are expected in future years and the ATAP packages describe a strategic direction that seeks to address this challenge. Some of the interventions such as CRL other improvements to heavy rail, and mass transit public transport improvements such as LRT, BRT will also serve increasing numbers of commuters, as will buses. Major road improvement projects close to the CBD, such as the additional harbour crossing, are also highly likely to have significant impacts on CBD congestion.

The Auckland Transport Central Access Plan (CAP) is developing a new bus and mass transit service plan for Auckland and seeks to establish a small number of "high capacity" PT corridors that will bring commuters from suburban and more distant locations into the CBD. These corridors are to be served by collector bus routes (i.e. they will offer "multi-seat" journeys into the CBD and will require many users to have a least one change of PT vehicle to complete their journey.

ATAP has sought to gain more detail from the CAP team regarding its current plans, underlying assumptions regarding corridor capacity and its expectations in regard to the impacts of increasing demand in future decades. The CAP team has been helpful and offered assistance where it can. The CAP is at an early stage and is currently developing an indicative business case and is using demand estimates that do not anticipate a significant future shift from car to PT as is anticipated with the final indicative package.

Figure 5 below (from Round 4 of the package development) shows how the FID results in a significant reduction in car trips (approximately 20,000).

Figure 5 Change in AM peak hour car trips with the FID

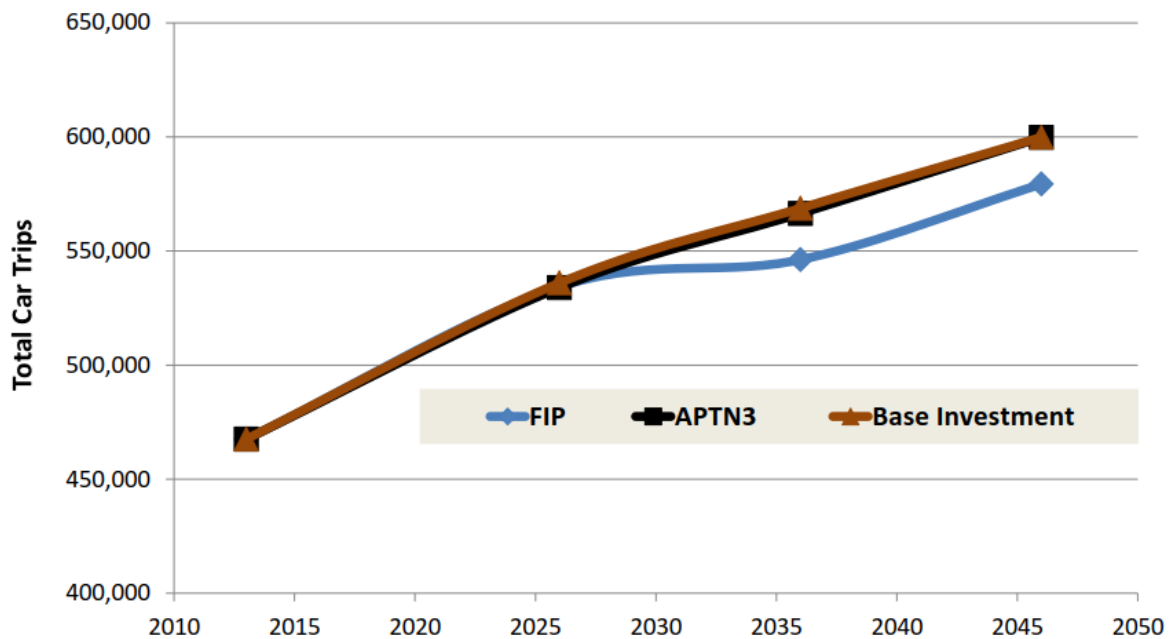
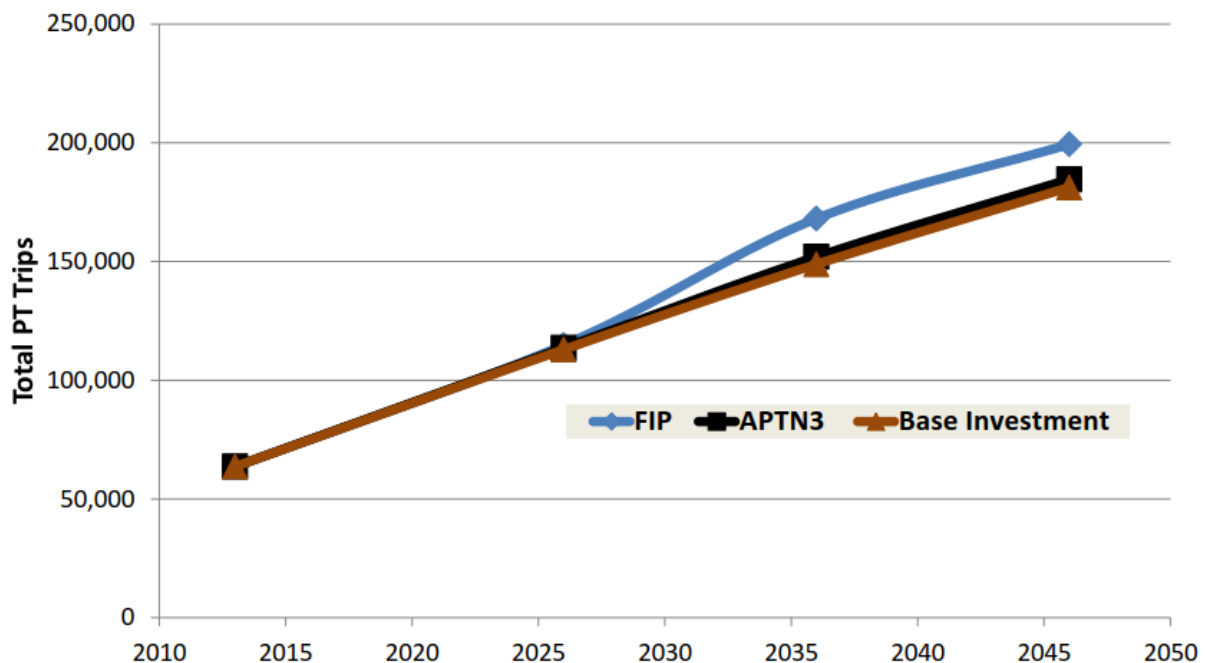


Figure 6 below shows a very similar increase in PT trips arising from smarter transport pricing in the FID. The increase in 2035 is approximately 20,000 PT trips, some of which will be on buses.

Figure 6 Increase in PT trips in the AM with the FID



The impact of the ATAP interventions on congestion results have only been tested through the use of the strategic modelling which represents corridor congestion as Volume/Capacity ratios. The ART model is an unconstrained and will permit all trips to be completed within the modelling period. This does not therefore reflect congestion in dense urban networks well or represent crowding on Public Transport (PT) vehicles. The APT model has a crowding function and therefore better reflects the ability for PT users to board a PT vehicle. Neither the ART nor the APT models reflect network congestion well in urban environments and their assessment is likely to be significantly over estimating the likely performance of the road network.

Best practice to understand urban congestion in city centres is through the use of microsimulation or mesoscopic modelling. These types of model much better represent queuing and delay at intersections, lane use and bus impacts. The ATAP schedule is insufficient to test the congestion impacts of the population, employment distribution and the ATAP packages through the use of such modelling techniques.

The above shows that with the current level of development of the CAP, its assumptions regarding future demand, and the suitability of the tools available, there is a risk that bus PT trips into the city along some corridors cannot be served.

To gain a much more robust understanding of the performance of the road network in the centre of the CBD will require that CAP accounts for the car to PT trips in its work and further microsimulation or mesoscopic modelling after the final ATAP deliverable.

6.8 Schedule risks

As noted in the preceding sections of this report, many of the interventions being considered in ATAP will have long legislative, policy, planning, approvals, procurement and delivery processes. This may require work to be undertaken several years in advance. A high level programme that documents when these processes need to commence for major projects should be established concurrent with the finalisation of the optimised ATAP package and final deliverable.

6.9 Organisational capability

The final indicative package recommends a markedly different strategic direction to that previously adopted by the ATAP agencies. The inclusion of smarter transport charging and a means to encourage transport users to make travel choices using more efficient transport modes will require the development of new capabilities in the agencies.

Similarly, a greater emphasis on making better use of existing networks by; optimising key routes for greater productivity, improving asset management efficiencies and maximising benefits from new transport technologies are likely to make increased demands on organisational capacity and capability.

Experience in Australia when State transport agencies have sought to optimise their transport assets has shown that to do so efficiently and effectively have required changes to their organisational policies, structures and capabilities. The need for such changes to manage congestion has been highlighted in a number of Auditor General Reports. These include:

- “Managing Traffic Congestion” - Victorian Auditor-General’s Report April 2013,
- “Main Roads Projects to Address Traffic Congestion Western Australian” Auditor General’s Report March 2015
- Transport network management and urban congestion in South East Queensland - A Performance Management Systems Audit”, Report to Parliament No. 3 for 2009.

6.10 External risks

6.10.1 Legislation change

As noted in section 5.1.1, several of the interventions in the ATAP FIP will require legislative changes. The ability to achieve these changes and time required to pass such legislation is not yet known.

6.10.2 Construction industry capacity

The scale of the infrastructure interventions included in the final decade of the FIP will require significant construction capacity. The timing of ATAP interventions and other construction activity may impact the ability of the Australasian construction industry to support the scale of the infrastructure planned by ATAP.

7.0 Post ATAP work

7.1 Delivering ATAP recommendations – follow-on activity

The ATAP final indicative package will see a marked change in transport investment and policy.

The delivery of this change will require alterations to be made to established policy and plans. Significant research may also be required to delivering smarter transport pricing and encourage change in people's travel choices.

The following areas will require action or review:

- Production of an early action plan setting out the tasks and timelines to embrace the potential offered by evolving transport technology and delivering smarter transport pricing. The action plan will need to cover such matters as a review of the potential need for changes to taxation, changes to legislation, research / surveys of people's likely response to such innovation.
- Confirming costs and benefits of major interventions recommended by ATAP. This may include the development of a number of indicative business cases with greater understanding of likely benefits and of construction, land and operating costs.
- Development of improved modelling tools that better represent travel choices to smarter transport pricing and responses to evolving transport technologies.
- The potential need for organisational change to develop a broader capability needed to deliver smarter transport pricing and an increased focus on network optimisation.
- A review of the transport resilience of the key transport corridors which are significant in Auckland and New Zealand productivity.

8.0 Conclusions and recommendations

8.1 Conclusions

Based on the work undertaken and evidence prepared by the participating Government organisations, the following conclusions have been identified:

- The methodology used within ATAP has identified a well-considered final indicative package of transport interventions that respond to forecast future transport challenges.
- The final indicative package of infrastructure proposals is acceptably optimised given the information currently available and the ATAP schedule.
- Further optimisation of the final indicative package is recommended as the designs for its infrastructure components are developed.
- The work undertaken and the conclusions reached by ATAP were NOT biased by earlier planning or infrastructure plans. The ATAP work can be considered as "fresh thinking".
- The methodology and research work undertaken followed a systematic and logical approach.
- The ART model data used in the value for money assessment of intervention packages is only suitable for comparison of similar sized packages. Further more detailed work will be required to assess programme level and individual project benefit cost ratios.

8.2 Recommendations

AECOM recommends the following:

- A risk and mitigation register is established to record both package specific and common risks and to manage mitigation needs.
- ATAP should develop an "assumptions book" that documents the assumptions made that support the ATAP recommendations and analysis.
- The decision to exclude the CBD cordon pricing demand management option from round three of the package refinement limited ATAP's understanding of options for the use of pricing as a means of demand management.
- A high level programme of ATAP interventions should be developed for the first decade and this programme should include legal, policy, change requirements. In relation to infrastructure interventions the programme should indicate key dates to initiate approvals and procurement activities for projects to be delivered in the first decade and for ALL major projects (value greater than \$1bn).

- To improve confidence in the outcomes of changes to transport technology and the impacts of pricing to manage demand, further modelling work will be required after the conclusion of ATAP and a strategic model be developed that can better reflect perceived changes in the cost of travel and ride sharing.
- For the ATAP agencies to have confidence in the likely impacts of the use of smarter transport pricing to manage demand and to better understand the impacts of changing technology, improved strategic modelling tools are needed. The development of such tools may take in excess of a year. Any tool developed for this purpose will need to provide a range of functionality not currently provided by the ART model. Ideally the research necessary to develop such a model should take place for this before the next census and the planned updating of the ART model in 2018.
- That the road components of the renewals operation and maintenance paper is updated to reflect how the ATAP agencies will respond to how the Auditor General's feedback on maintenance and renewals is to be actioned.
- That where BCR's are documented that were produced using ART model data caveats should be provided, making clear that they are provided as comparators only and business cases will be produced to verify the value for money of individual projects / interventions.
- In the next 12 to 18 months, indicative business cases be developed for the key interventions that deliver the majority of benefits in the second and third decades of ATAP. This will mitigate the uncertainty in BCR's that arise from the current limited levels of project development of the preferred investment programme.
- A resilience review of key transport infrastructure is undertaken shortly after the completion of the final ATAP deliverable to determine if any additions or alterations are necessary to the ATAP recommendations to mitigate network resilience risk.
- The ATAP agencies continue to pursue post ATAP means mutually agreeing an approach to balancing the needs of Arterial road performance and amenity. Such an agreement is a precursor to establishing a forward programme that would deliver highly cost effective improved outcomes.