Programme Business Case

SH1 Cambridge to Piarere Improvements

28 July 2015

NZ TRANSPORT AGENCY WAKA KOTAHI

New Zealand Government

Approval

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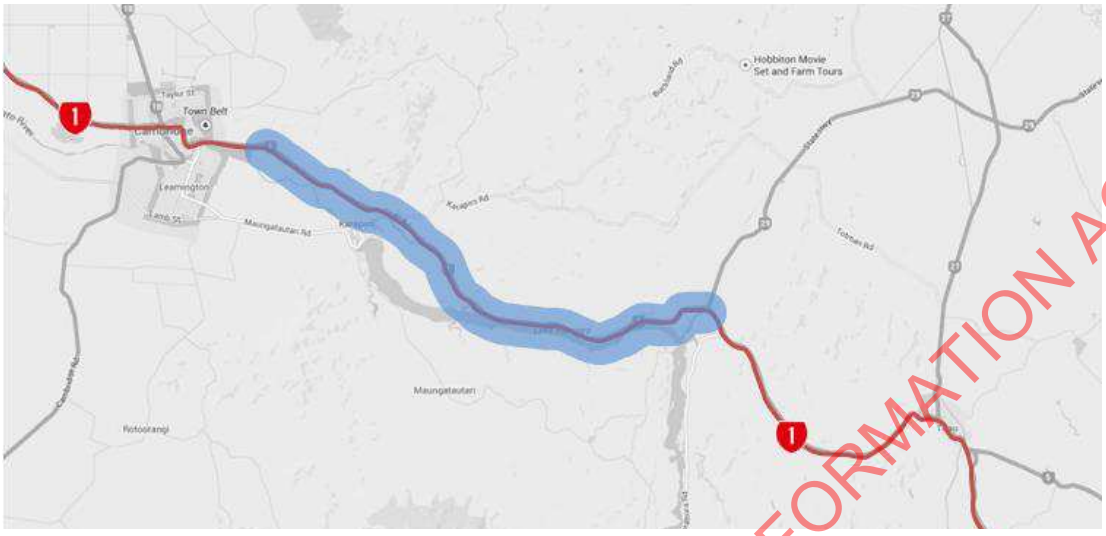
Contents

Executive Summary

State Highway 1 between Cambridge to Piarere is part of a number of key journeys which link Auckland and Hamilton with Tauranga, specifically the Port of Tauranga via SH29, as well as central and lower North island via SH1. This business case considers that stretch of SH1 from the end of the Waikato Expressway through to, and including, the intersection with SH29 at Piarere.



The Hamilton to Waiouru Strategic Case, the Hamilton to Tauranga Strategic Case and the National Safer Journeys Roads & Roadsides Programme Business Case confirmed the case for change and this business case presents a programme of activities which most effectively delivers the transport outcomes sought on SH1 between Cambridge and Piarere.

The key problem currently experienced on this stretch of SH1 is related to road safety and the numbers of deaths and serious injuries which take place on this road. Also, the frequent side roads and private access has resulted in a medium/high risk profile for the corridor, causing closures of the road along the corridor for substantial amounts of time affecting reliable journey times.

SH1 is a national high volume route and an important artery for freight and general traffic as it connects Auckland and Hamilton with the rest of New Zealand. SH1 caters for a mix of local and strategic long distance traffic (10% heavy traffic), operating at a generally acceptable level of service. This section of SH1 is the linkage to the soon to be completed Cambridge Section of the Waikato Expressway (WEx) where drivers travelling south will transition from the high standard expressway to a single lane rural road with passing lanes. Traffic demand is predicted to increase, not only as a result of growth in traffic volumes but also as a result of how customers use the SH network following opening of the Waikato Expressway. This will result in delays as the local traffic from the frequent side roads and private accesses mixes with the strategic long distance traffic.

These traffic delays along SH1 are further exacerbated by the need to clear the safety incidences, which can cause significant delays and impact on the journey reliability. The increasing conflict between local and through traffic is likely to negatively impacton journey time reliability and undermine the benefits of the Waikato Expressway. Following completion of the Waikato Expressway it is expected that there will be an increase in traffic volumes by up to 2000-3000 vehicles a day with a further increase in future years.

The problem and benefit statements have been refined with our stakeholders, from the high level Hamilton to Waiouru Strategic Case to specifically understand the safety and efficiency concerns as it relates to the Cambridge to Piarere section. The following problem statements were agreed as:

- **Problem 1:** Poor driver behaviour coupled with a sub-standard road design for its current function leads to a high crash rate along the corridor (40%)
- **Problem 2:** Competing priorities of access and throughput along the corridor has contributed to the crash history (20%)

- **Problem 3:** Future demand for the corridor is expected to exceed capacity potentially reducing the regions ability to support growth (40%).

Similarly the following benefit statements were also agreed:

- **Benefit 1:** Improved safety (70%)
- **Benefit 2:** Improve/maintain economic efficiency along SH1 (and SH29) corridor (30%).

It is believed that the medium/high crash risk combined with the increase in traffic on the opening of the Waikato Expressway mean that the problems warrant addressing at this time. Also by addressing the benefits, the whole route will improve in safety, journey reliability and throughput, making it not only a more efficient north/south journey but also improve the safety and efficiency of the Hamilton to Tauranga journey and further south

The problems and benefit statements, along with technical supporting work, have enabled us to confirm the transport outcomes sought on this stretch of SH1 between Cambridge and Piarere as:

1. **A low crash rate with a reduced death and serious injury record appropriate for a national high volume route**
2. **Improved journey time reliability** consistent with customer levels of service experienced on Waikato Expressway
3. **Supporting economic growth of upper North Island** (preferred route choice for freight between Auckland and Tauranga supporting the One Network Roading Classification)

Improved journey time reliability is important along this stretch of SH1, and the issues and problems associated need to be considered in context of how the SH network operates within the upper North Island. In this instance, traffic using the Waikato Expressway will continue directly onto SH1 and it is only at Piarere that the traffic splits, heading to Tauranga via SH29 in the east (55%) and further south via SH1 (45%). Therefore a transport outcome related to improved journey time reliability will ensure the benefits and objectives of the Waikato Expressway are further supported.

Alongside these transport outcomes, the One Network Roading Classification indicates aspirational Customer Levels of Service for different classes of road. For SH1 between Cambridge and Piarere, a national high volume route, the gap is shown below

	Desired Outcome	Actual Performance	Performance Gap
Safety performance	4 Star KiwiRAP	3.1 to 3.4 Star KiwiRAP	0.6 to 0.9 Star KiwiRAP
Travel time reliability and efficiency	Reliable and improving At 100km/h travel time is 10.2min	12.7min in 2014 and forecast to worsen to 18min in 2040	2.5min in 2014, worsening to almost 8min in 2040
Speeds	100km/h, 90km/h for freight	Varies, 80km/h in peak hour in 2014, forecast 60km/h in 2040	20km/h lower than desired in 2014, worsening to 40km/h in 2040
Resilience	Alternative is always available	Alternative is available, although level of service is less than state highway standard	Acceptable – however, impacting on the travel time reliability of the route
Amenity	Journey quality responds to topography, generally good ride comfort	Journey quality responds to Lake and hills. Ride comfort generally good.	Acceptable
Accessibility	Grade separated interchanges on RONS, otherwise widely spaced intersections	Intersections widely spaced, although clustered in areas and with safety issues	Unsuitable intersection form and spacing.

Based on the evidence analysis and the gaps in levels of service the need for a range of interventions was considered, from minor through to consideration of capacity improvements and a step change of safety rating targeting a 4 Star road. These were all considered as being consistent with the level of service of both safety and journey improvements provided by the WEX. These have been considered

and assessed in terms of how they deliver these transport outcomes (and more detailed investment objectives which sit below them).

Whilst stakeholders initially agreed that a combined safety and efficiency programme was the most effective programme, further analysis has shown that the costs could be much greater than originally anticipated and hence further work is required to determine the incremental benefits of potential solutions. However, it is clear that the problems with road safety need to be responded to now while efficiency problems require further monitoring and work.

Our recommended programme is to stage improvements of relatively low cost short to medium term safety improvements and in the long term raise the level of service in safety and efficiency to provide a suitable transition of the Waikato expressway. We believe that the recommended programme will be able to address the concerns identified within the problem statements and achieve 70% of the safety benefit and 80-100% of the efficiency benefit, making this Programme a favourable investment.

As such the recommended programme of activities on SH1 between Cambridge and Piarere consists of:

1. Short term online safety improvements (0 to 3 years)
2. SH1/29 Intersection Improvements (6 to 10 years)
3. Longer term efficiency improvements (10 years+)

We are confident that by taking a staged approach addresses safety concerns in the first instance and having sufficient time to take a measured course for the improvement of the overall level of service on the corridor. This approach will provide a robust value for money solution to address the problem statements and deliver the benefits sought for the corridor.

It is recommended that the next stage of business case development continues for the Short Term Online Safety Improvements and the Longer Term Efficiency Improvements. The latter will consider both online and offline options in more detail. Progressing both work streams concurrently is important to ensure the long term plan is known before committing significant costs and to enable a thorough understanding of any possible sunk costs.

In terms of the SH1/29 Intersection Safety improvements, investigation is already underway however the preferred option will need to be tested against the longer term activities.

This Programme Business Case sits alongside other concurrent work streams. One of those is the over-arching objectives for investing in the Waikato Expressway is to attract traffic from alternative routes through the region on to SH1, so we can improve safety outcomes and focus our investment in a (national high-volume) corridor. While the WEX progresses, improved safety outcomes on the network need to be delivered now and we need to ensure we have a robust plan for the future which will ensure the identified problems are resolved and not just postponed.

Running alongside this work stream, there will also be two other Programme Business Cases being developed for the remaining sections of SH1 through to Waiouru (Piarere to Taupo and Taupo to Waiouru), identified as priority areas for improvement. This will ensure that a corridor approach is taken to improving State Highway 1 within the Waikato Region.

At this stage of the Programme key risks have been identified as:

- Safety problems and issues would still exist and could get worse in the short term. Deaths and serious injuries will continue to occur and SH1 Cambridge to Piarere will remain a Medium-High risk section of the corridor.
- The travel times savings gained on the Waikato Expressway will be eroded as congestion on this section of the corridor increases with traffic growth. The significant investment in the Waikato Expressway will be compromised and at risk.
- Failure to address capacity will result in all three of the identified problem statements recurring due to the increase in traffic flow over time and due to the opening of the Waikato Expressway.
- Also by failing to address the capacity concerns, drives may choose other routes, such as SH2 or SH27, undermining the over-arching objectives of the WEX.

- Further work is required to understand the most effective response to the longer term efficiency problems – the upcoming Business Case will consider more fully the associated risks including land take and property acquisition, as well as cultural and environmental impact, before a decision can be made.

The recommended programme offers significant improvements to the SH1 corridor between Cambridge and Piarere, delivering on the agreed transport outcomes – improving safety, journey reliability and throughput and in turn, supporting the economic growth and vitality of the upper North Island.

The full programme outcomes will be delivered upon completion of the longer term improvements – 70 to 90% safety benefits and 80 to 100% efficiency benefits for a total estimated cost range of $300M-650M over a 15 year period. Until then, the short term actions will only deliver part of the outcomes but this will be at much reduced cost and over the next 3 years.

It is recommended that the next stage of the Business Case approach should be progressed at the earliest opportunity.

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PART A – THE STRATEGIC CASE

As a national high volume route, SH1 will continue to focus on moving high volumes of traffic including freight within the region and long distance traffic between the lower and upper parts of the North Island, connecting major centres of population, and catering high levels of tourist traffic. Strategic Cases for Hamilton to Waiouru and Hamilton to Tauranga, as well as the National Safer Journeys Roads & Roadsides Programme Business Case, have confirmed the case for change and the need for this Programme Business Case. There have been no changes in relation to the network or land use hence there is still a need to consider an appropriate programme of activities to respond to the problems of safety and efficiency on SH1 between Cambridge and Piarere.

1 Introduction

The stretch of SH1 from Cambridge to Piarere is part of a number of key journeys which links Auckland and Hamilton with Tauranga, specifically the Port of Tauranga via SH29, as well as the central and lower North Island via SH1. It extends from the end of the Waikato Expressway at Cambridge through to the intersection with SH29 at Piarere.

Strategic cases for the Hamilton-Waiouru (SH1) and Hamilton-Tauranga (SH1/29 and ECMT) have been developed and set out the strategic assessment and context for future investment to improvements. The Strategic Cases identify jointly agreed problems associated with the corridors with key stakeholders, assess how significant they are from a national perspective, and the potential consequences of not addressing them. Both strategic cases confirmed there was a case for change, and provides the basis for working out what are the right things to do to enable SH1and SH29 to continue to function effectively as a national route.

The broader corridor has been broken down into smaller sections for further consideration and this SH1 Cambridge to Piarere PBC is one of them. In developing the programme of activities for this shorter section, it is important to consider it in context of the higher level corridors.

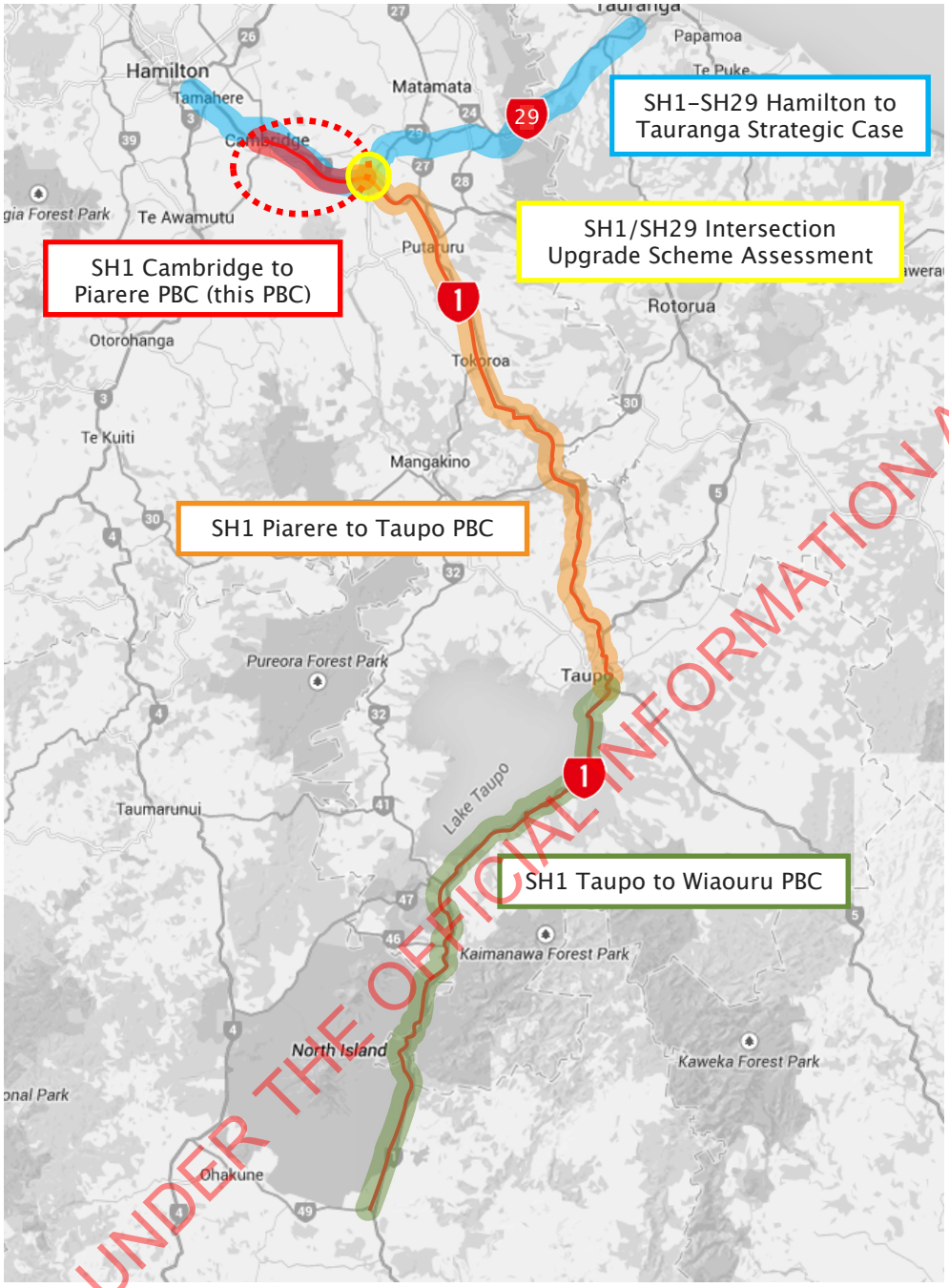


Figure 1-1: SH1 Cambridge to Piarere Corridor and Business Cases in the vicinity

This Part A considers these broader corridors – Hamilton to Waiouru and Hamilton to Tauranga – and confirms that the problems still exists and benefits identified are still sought. It should be noted that in developing the Hamilton to Waiouru Strategic Case, the corridor was further divided into two section as shown above in Figure 3-1 (Hamilton to Taupo and Taupo to Waiouru).

As a national route, SH1 role will continue to focus on moving high volumes of traffic including freight within the region and long distance traffic between the lower and upper parts of the North Island, connecting major centres of population, and catering high levels of tourist traffic.

2 Partners and Key Stakeholders

Development of the high level corridor strategic cases has involved engagement with the key stakeholders collectively through the Investment Logic Mapping (ILM) and Benefit Mapping workshops as many of the problems, potential benefits and programme development activities require an integrated and collaborative approach.

The activities and problems relating to the corridors affect a number of different organisations and users. In terms of informing the development of the strategic cases, the ILM and benefit mapping workshops included the following key stakeholders:

- NZ Transport Agency – Highway Networks Operations
- NZ Transport Agency – Planning and Investment
- Respective Local Territorial Authority e.g.Taupo District Council, Matamata Piako District Council (representing rural councils in project area), Tauranga City Council, Western Bay District Council
- Waikato Regional Council
- Freight Logistics Action Group
- NZ Police
- KiwiRail (Hamilton to Tauranga Strategic Case)
- Port of Tauranga (Hamilton to Tauranga Strategic Case)

KiwiRail were unable to attend the Hamilton-Taupo-Waiouru workshops however there have been separate discussions with KiwiRail, Road Traffic Association and South Waikato District Council.

3 Strategic Assessment – Outlining the Need for Investment

The Strategic Cases for the higher level corridor:

- outline the strategic context and fit for improving the corridor
- identify the key problems, and the consequences of not addressing these, and
- identify the potential benefits sought, and hence the case for change.

It is important to understand these to ensure that any programme of activities undertaken on the SH1 Cambridge to Piarere stretch will support the benefits sought on the broader corridor.

3.1 High Level Corridor Problem statements

Facilitated ILM workshops for the Hamilton to Taupo (part of the Hamilton to Waiouru Strategic Case) and Hamilton to Tauranga corridors took place in late 2013 with key stakeholders to gain a better understanding of current issues and to explore the case for change for these corridors. The stakeholder panel identified and agreed a number of key problems that would drive and influence future investment on SH1. These are set out below:

Hamilton to Taupo section

- **Problem 1:** Driver fatigue in long haul through traffic results in a greater than average number and rate of high speed crashes with a high probability of a 'severe outcome' **(50%)**
- **Problem 2:** Closures of the long haul SH1 north-south spine will result in material loss due to delay of goods getting to markets **(30%)**
- **Problem 3:** The small towns on the route impede traffic flow and increase journey times **(20%)**.

Hamilton to Tauranga section

- **Problem 1:** Disruption to freight movements to and from the Port of Tauranga results in economic loss to New Zealand
- **Problem 2:** The physical alignment and unforgiving nature of the road and roadside, combined with the high volumes of both local and strategic traffic expose people to an unacceptable risk of death or serious injury should they crash
- **Problem 3:** If the route does not support the efficient movement of freight, traffic will move to alternative local routes, increasing maintenance costs and risk to safety across the network (20%).

Both the Hamilton to Waiouru and Hamilton to Tauranga business cases overlap the SH1 Cambridge to Piarere section highlighting the importance of this link. Both sets of problem statements highlight issues with road safety and efficiency, particularly freight efficiency. During workshops, the stakeholder panel raised some concern the impact of the Waikato Expressway in particular related to safety and the potential change in form of the carriageway between the new and existing carriageways the change in environment for drivers. There was also discussion about the possibility of attracting traffic from other routes which could exacerbate the safety problem. It was noted that work was underway to ensure an appropriate tie-in with the existing SH1 however there was concern that further work may yet be required. At the high level corridors, discussion of problems was not detailed enough for the Cambridge to Piarere section and hence further workshops have taken place. This is detailed in Part B.

3.2 High Level Benefit statements

The potential benefits of successfully investing to address the above problems were identified as part of further workshops, again held in late 2013. The stakeholder panel identified and agreed the following potential benefits along, with the respective ratings to reflect the relative significance of each. These are set out below for both the Hamilton to Taupo (as part of the Hamilton to Waiouru Strategic Case) and Hamilton to Tauranga corridors:

Hamilton to Taupo section:

- **Benefit 1:** Improved safety rate (60%)
- **Benefit 2:** Efficient movement of key north-south freight (40%).

Hamilton to Tauranga section:

- **Benefit 1:** Route enables economic growth (25%)
- **Benefit 2:** Route supports wider transport network (45%)
- **Benefit 3:** Enable mode shift (30%)
- **Benefit 4:** A safer corridor with a reduced risk of death and serious injury (4th benefit added later and weighting not yet confirmed with stakeholders)

The potential benefits in relation to the SH1 Cambridge The ILM Problem and Benefit Maps are attached as **Appendix A**. The stakeholder panel also recognised that this section of SH1 will be affected by the future development of the Waikato Expressway. The panel raised concerns over how the Cambridge section of the Waikato Expressway would tie-in with the existing SH1 just south of Cambridge; these primarily related to safety concerns and the potential change in form of the carriageway between the new and existing carriageways. At the time of the workshop the National Business Case for Safer Journeys identified a number of sections of the SH1 corridor as high risk road requiring action in the short and medium term. The section between Cambridge and Piarere was one of those requiring action in the short term, and it was agreed that this issue relating to the tie-in would be addressed as part of the business case being developed for this shorter section.

Importantly, both sets of problem and benefit statements for the Hamilton to Taupo/Waiouru and Hamilton to Tauranga sections are closely aligned with the identified problems of safety, competing priorities between local and through traffic, and future demand impacting on capacity for growth; as well as the benefits of safety and economic efficiency. This Programme Business Case focuses on the shorter section of SH1 between Cambridge and Piarere and Part

B of this document goes on to explore in more detail the problems and benefits sought associated with this shorter length of the corridor. As the business case continues to be developed and any activities implemented, it will be important to ensure alignment with the higher level corridor statements.

4 Strategic Context

To consider the role of SH1and how best to respond to current and anticipated problems, it is important to understand the context in which we are working. The GPS 2015/16-2024/25 looks to focus investment to improve capacity and service levels on existing State Highways, deliver a land transport system that is a safe system, and increase the percentage of the State Highway network open to high productivity motor vehicles but we need a closer look at what this means for this part of SH1.

4.1 Upper North Island

The Upper North Island Strategic Alliance and the various Regional Land Transport Plans recognise the importance of SH1 as a key national and inter-regional route. The Upper North Island Freight Story in particular noted that SH1 (from Pokeno through to Piarere) had a high potential in reducing the cost of doing business from an upper North Island perspective. A significant investment has already been made through the Roads of National Significance Programme and specifically the Waikato Expressway, which runs from Pokeno to just south of Cambridge.

The UNI Freight Story also recognises the role of rail and its interactions with the state highway network and whilst the impact of rail on this part of SH1 is not fully understood, further work is anticipated and the programme business case will take account of this through sensitivity testing.

4.2 Waikato Expressway

One of main objectives of the Waikato Expressway is to support SH1 and SH29 as the preferred freight route between Auckland-Hamilton-Tauranga and Auckland and destinations further south, over and above SH2 and SH27. This is being delivered through reducing travel times and provision of a high quality highway.

The section of SH1 further south through to Piarere is the focus of this Programme Business Case. During the development of programme options, the interaction with the Waikato Expressway and the broader upper North Island needs to be considered to ensure any benefits being realised through current investment is not undermined.

The Waikato Expressway responds to growth in inter-regional traffic. This includes the anticipated doubling of freight traffic in the Waikato region by 2035, as well as future population growth and demographic change within the region leading to an increase in traffic generation and congestion.

The region has a poor safety record with a high proportion of the national road related deaths and serious injuries (DSIs). Increasing growth has the potential to impact negatively on road safety outcomes. Historically SH1 has catered for both the longer distance and the local journeys, with this conflict impacting on the quality of life in the urban and residential areas along the route, as well as people's choice of travel.

In response to these pressures the Waikato Expressway has the following primary objectives:

a) To enhance inter-regional and national economic growth and productivity;

b) To improve journey time reliability and relieve congestion through the main urban centres along SH1;

c) To improve safety and reduce crashes on regional arterials, including SH1;

d) To focus freight movement onto SH1 rather than upgrade alternative routes; and

e) To provide improved local network operation and opportunities for improved urban design, travel choice and community connectivity within the major urban areas bypassed by the Expressway.

In the context of the SH1 Cambridge to Piarere section these objectives need to be considered as to whether the objectives of the Waikato Expressway will be supported on this section of the corridor.

4.3 National Programme Business Case for Safer Roads and Roadsides

The National Programme Business Case for Safer Journeys Roads and Roadsides identifies the majority of the SH1 corridor between Hamilton and Waiouru as high risk roads requiring action over the next 10 year period. In particular The Cambridge to Piarere section has been identified as a High Risk road for short term action (0 to 3 years) and the SH1/29 Intersection has been identified as a High Risk Intersection for action in the 6 to 10 year period.

The collective risk along this section of SH1 is in the Medium-High risk band (Table 4-1), and is higher than most of New Zealand's state highway network.

Table 4-1: Summary of key safety issues on SH1 Hamilton to Waiouru

Section	Typical AADT (2014)	Star Rating	Collective Risk Band	Personal Risk Band
Cambridge to Piarere	15,181	Ranges from 3.1 to 3.4 Star	Medium-High	Low

The key contributory factors shown are higher than the national average for all state highways. Fatigue and excessive speed are dominant factors in injury crashes on this section, and these are higher than the national state highways average. For many long haul journeys (for example to and from the lower North Island, Waiouru and Auckland) drivers will have been travelling for several hours before reaching this section of SH1, and hence fatigue will start building and becoming a factor for many.

4.4 National Resilience Business Case

Network resilience is focussed on keeping the state highway network open, or ensuring that an alternative route is always available, with priority given to the national routes and high volume routes. The National Resilience Programme Business Case has identified SH1 as a high priority for action.

In terms of SH1 the issues of resilience vary along the route. The Hamilton to Waiouru Strategic Case noted that road traffic incidents and crashes were a primary reason for closures of SH1 between Hamilton and Taupo; however further south of Taupo the issues were more weather and environmental related.

4.5 One Network Road Classification

The One Network Road Classification (ONRC) categorises roads by function, defines the fit for purpose outcomes by determining a Customer Level of Service (CLOS), and develops performance measures for maintenance, operational and investment decision making.

This section of SH1 is classified as a High Volume national route. The suggested CLOS relevant for this route classification are:

- **Travel time reliability and efficiency:** Reliable and improving
- **Resilience:** Route or alternative is always available
- **Speeds:** High speed; 90km/h for freight; 100km/h for motorways and expressways
- **Safety performance:** Generally 4 Star KiwiRAP with targeted prevention of fatal and serious crashes and protection from harm
- **Amenity:** Journey quality influenced by topography with generally good ride comfort
- **Accessibility:** Grade separated interchanges on RoNS otherwise widely spaced intersections.

This programme business will seek to how these CLOS apply to SH1 and particularly the Cambridge to Piarere stretch. It is quite evident that the Waikato Expressway RoNS provides these CLOS however, it must not be assumed that remaining stretches of SH1 will take the same form. Delivery of outcomes alongside value for money are key considerations.

5 Changes/Updates to the Strategic Case

The Strategic Case for SH1 Hamilton to Waiouru was completed in August 2014 following consultation by internal and external stakeholders, and was supported by the HNO Value Assurance Committee in August 2014. Similarly the Hamilton to Tauranga Strategic Case was supported by VAC in January 2015.

Other that minor refinements, there have been no issues stemming from the work to develop the Strategic Case and the subsequent consultation and approval processes specific to the Cambridge to Piarere section of the corridor that have required a review and/or an update of the strategic assessments for SH1.

There have been no significant changes to land use or improvements made to the SH1 Hamilton to Waiouru and Hamilton to Tauranga to suggest that the strategic cases and therefore the case for change needs to be reviewed.

Moreover, crashes continue to occur along the Cambridge to Piarere section and whilst traffic growth levels may have slowed down, the increase in traffic levels are still anticipated – more a case of when, not if. There is some evidence available which indicates that the Waikato region has experienced an increase in GDP which can be correlated to increase in trucks, again supporting the case for change.

PART B – DEVELOPING THE PROGRAMME

6 Programme Context

This Programme Business Case focuses on that part of SH1 which extends from the end of the Waikato Expressway at Cambridge through to its intersection with SH29 at Piarere. A more in depth review has confirmed that there are problems related to road safety along the corridor as well as the likelihood of efficiency problems in the future (if traffic growth levels grow as predicted). Different programmes have been tested to ensure they respond to these problems and subsequent investment objectives and a recommended programme developed. Whilst stakeholders initially agreed that a Combined Safety & Efficiency Programme was the most effective programme, the work undertaken has shown that a **staged approach** is required and hence **short term safety improvements followed by long term efficiency improvements** is recommended.

6.1 Geographical, Environmental & Economic Context

This Programme Business Case is concerned with the section of SH1 from the end of the Waikato Expressway at Cambridge and the SH29 intersection at Piarere, as shown in Figure 6-1.

In terms of the natural environment this section is dominated by two features – Lake Karapiro which runs immediately to the south of SH1 for the majority of the length of this section, and the steep Karapiro hills alongside long sections on the northern side of the carriageway. These hills present a constraint for the transport corridor, limiting its ability to expand, as well as for the development along the corridor, with little suitable land for activities other than farming or the current roadside activities. The land-uses adjacent to this section are predominantly agricultural and horticultural and sports/recreational based, including several small commercial businesses located along the route. Due to the proximity of Lake Karapiro and the Waikato River, there are a number of lay-bys which provide access to boat ramps etc.

Lake Karapiro is an international rowing venue and home to the National Rowing Academy. The Lake is located immediately south of the state highway, with associated land-uses including recreational and occasional sporting events.

At the western end of the route is Cambridge, the largest centre for residential and commercial growth in the vicinity of the corridor. The Karapiro township is located towards the northern end of the section and accesses SH1 via Hydro Road. The Karapiro School is also located adjacent to the state highway with access via Karapiro Road. There is a petrol service area (Mobil Karapiro) which is also located immediately adjacent to the Karapiro Road intersection.

The Waipa District Growth Strategy aims to accommodate growth within exiting urban areas such as Cambridge, where Council is able to consolidate the growth and control the rural subdivision and sprawl. Growth in the Karapiro village, which is identified as a "village growth" area is moderate with an additional 500 people, but growth in the large rural Karapiro area is not expected to be significant.

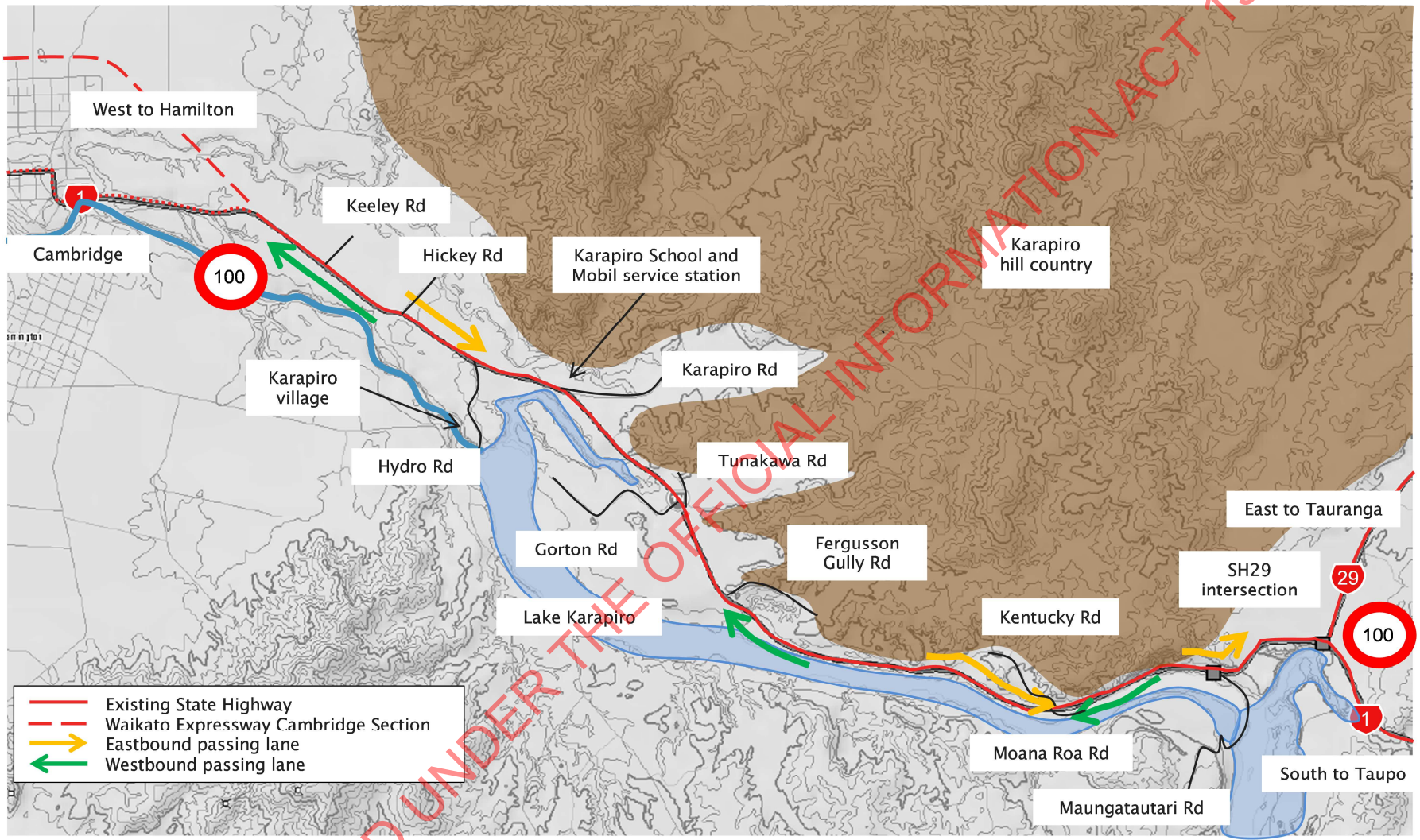


Figure 6-1: Extent of SH1 Cambridge to Piarere study area showing local context

6.2 Transport Context

Figure 6-2 shows the transport characteristics of the corridor showing location of side road at-grade intersections, passing lanes, and traffic flows. The alignment of this section of SH1 is relatively level and straight, with several curves along it that generally fit within the context of the prevailing speed limits. The posted speed limit is 100km/h. This section is a 2 lane carriageway and there are several passing and overtaking opportunities along this section, with 3 passing lanes in the northbound direction and 2 southbound. There are also several long straight sections that offer additional passing opportunities.

Rail

Whilst there are no rail lines in the vicinity of SH1 between Cambridge to Piarere, there are two major rail routes which connect Hamilton-Tauranga (East Coast Main Trunk (ECMT)) and Hamilton-Tokoroa (North Island Main Trunk (NIMT)). These routes are freight related services rather than passenger services. Whilst there is still work to be undertaken to fully understand the interaction between rail and road, discussions with stakeholders during the higher level corridor ILM workshops did not identify any major problems. At this stage, the intention is to test the rail interaction with any state highway improvement activity through sensitivity testing.

The freight route between Auckland and Tauranga is the country's busiest rail freight line, moving containerised and bulk goods to and from the ports of Tauranga and Auckland, as well as inland ports in Auckland and freight consolidation centres in Auckland and Waikato. The Ministry of Transport carried out a National Freight Demand Study in 2014 which found that the freight task in the Auckland, Waikato and Bay of Plenty regions is forecast to grow above the national rate, with a growth of over 60% by 2042 and account for nearly 50% of the nation's freight.

The section of SH1 from Cambridge to Piarere takes freight to and from the Port of Tauranga as part of the Auckland-Hamilton-Tauranga journey, and which over time has the potential to increase either through Port expansion or entrance channel deepening to permit larger vessels.

In addition to the potential for the expansion of port related freight to and from the Port of Tauranga, the potential Ruakura inland port on the east of Hamilton, which will have direct access to the Waikato Expressway, has been given approval for a Hamilton City plan change by the Environmental Protection Authority for 600Ha of commercial and residential development. This proposed transport hub will over time attract and distribute both road and rail traffic, with SH1 playing an important inter-regional link. The road and rail links to Tauranga are understood to have an important role in the successful operation of the Ruakura inland port.

Feedback from KiwiRail to date confirms that any likely increase in freight between Tauranga and Hamilton will largely be driven by Port of Tauranga requirements and bigger container vessels. KiwiRail note that any ECMT upgrade would maintain freight levels along the road network, and excess/additional freight would be accommodated by rail with the available ECMT rail capacity.

In the context of the SH1 Cambridge to Piarere journey there are potential impacts, where freight traffic between the origins and destinations of Hamilton, Tauranga, and Kinleith (or further afield) is likely to impact on the efficiency of the journey. The NIMT and ECMT both therefore have the potential to reduce or increase activity on the road, depending on the market requirements and demand for goods. Unfortunately this cannot be determined at this time, although it should be noted that long haul capacity on the network is available for those longer distance rail journeys in the North Island and central North Island, and therefore has the potential to relieve the amount of road based freight trips on the corridor.

Commuting passenger numbers along the Cambridge to Piarere route, or origins/destinations of longer journeys, do not appear sufficient to warrant dedicated commuter rail services in the foreseeable future.

Walking and Cycling

Walking and cycling is included along the Cambridge section of the Waikato Expressway. The Te Awa River Ride aims to provide a shared use pedestrian and cycle pathway for recreational and tourist users between Ngaruawahia and Horahora along the Waikato River[1]. The demand for on-road cycle facilities between Cambridge and Piarere has not been established, although continuation of the sealed shoulders for cyclists should be continued as a minimum.

Public Transport

There are no scheduled bus services on this corridor. Passenger trips by car along this corridor tend to be long distance travel or business trips with some commuting from rural residential properties.

School services are present, making random stops where flagged to pick up or set down student passengers. The stops are not carried out at formed bus stops however, and any upgrade of the corridor should consider appropriate facilities that are safe and convenient.

Long distance bus travel takes place through private operators, fulfilling the inter-city demand for travel. The service station at Karapiro Road is used as a refreshment stop for ablutions and meals, with access to the state highway via the Karapiro Road intersection.

Traffic Growth

Traffic flows along the corridor (measured at Karapiro) have for some time stagnated, but since 2012 growth appears to be occurring in all vehicles and in heavy vehicles. In 2014 all traffic grew by 3.8% and heavy traffic by 8.1% along the corridor. At the current average growth rates since 2012 there is likely to be pressure on the corridor in terms of capacity, initially at the termination of the passing lanes, but ultimately along the single lane segments.

The daily traffic flows along the corridor show a hybrid between a commuter corridor as well as a long distance journey corridor, with AM and PM peak periods evident without being prominent. This indicates that some commuting to Cambridge and Hamilton is occurring, as well as longer distance business travel, especially freight which is notably consistent between the peak periods.

The dominant traffic movements are strategic however, with long distance through traffic and HCVs travelling through this section of the corridor on journeys starting and ending outside of this section of SH1.

[1] http://te-awa.org.nz/

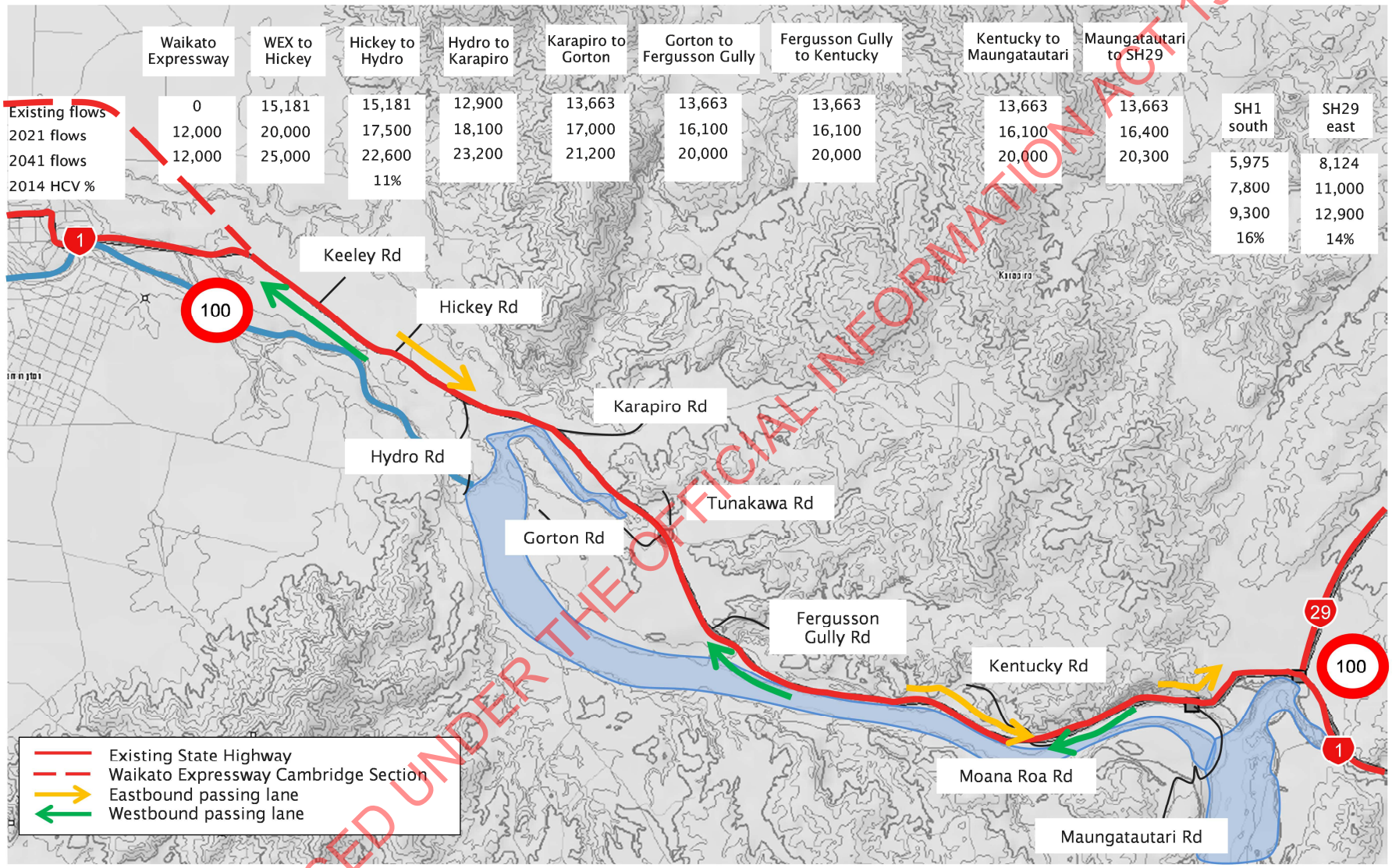


Figure 6-5: SH1 Cambridge to Piarere transport context

To the north of this section the soon to be completed Cambridge section of the Waikato Expressway will tie into the existing SH1 alignment. Expected completion of the Cambridge section of the Expressway is early 2016. Once complete the Waikato Expressway is anticipated to attract redistributed trips from SH2 and SH27, creating a step change in traffic flows (as shown in Figure 6-5 and as discussed in more detail in section 7.1.3). The expected increase in traffic flows will be approximately 3,000vpd (to a total of 18,000vpd approximately) on completion of the Expressway in 2019/20.

Form of Carriageway

The Cambridge Section of the Waikato Expressway is under construction and will bypass the Cambridge urban area. It is a high standard, four lane, median divided expressway with grade separated interchanges. The current state highway status through Cambridge is likely be revoked, with the Expressway being declared state highway. The termination of the Waikato Expressway is the start of this section of the Programme Business Case. From here on, SH1 is two lanes with three sets of passing lanes in each direction, with at grade, uncontrolled intersections.

Intersection Traffic

The transport context diagram (Figure 6-3) shows current traffic flows from 2014, as well as traffic flows for 2021 and 2041 as forecast from the WRTM[2]. Current traffic flows are extracted from the State Highway Traffic Data Booklet for 2014 and modified along the corridor according to NZ Transport Agency RAMM data[3]. The reasons for the traffic flow variations are due to the range of land-uses at different locations and number of intersections and accesses along this section. There are approximately 10 at-grade intersections along this section that accommodate turning traffic volumes of between 50 and 800 vehicles per day. Side road flows are approximately as follows:

The largest side road flows in and out of Hydro Road and Karapiro Road have the most notable impact on state highway flows. The highest flows are west of Hydro Road, indicating the attraction of Cambridge to users of Hydro Road. There is some uncertainty around the flows between Hydro and Karapiro Roads, with RAMM data showing that this is the lowest flow along the section, compared to the WRTM forecasting relatively high flows. The trend nevertheless is that flows generally increase from east to west as more traffic joins the route from adjacent land use activities.

Safety

The National Programme Business Case for Safer Journeys Roads and Roadsides identifies a number of high risk corridors and intersections on the state highway network. In particular it identifies this section of SH1 between Cambridge and Piarere as a High Risk corridor requiring action in the short term (0 to 3 years) and SH1/29 Intersection as a high risk intersection for action in the long term (6 to 10 years). Without intervention to improve the roads and roadsides, driver behaviours and use, the number of people being killed and seriously injured on SH1 will continue to rise. The Collective Risk[4] along this section of SH1 is Medium-High and Personal Risk[5] is Low.

As the current star rating of this section ranges between 3.1 and 3.4 there is a case to make this national route more forgiving to drivers making mistakes, alongside actions to improve driver behaviours and road use.

2 Waikato Regional Transport Model, Network 42

3 Provided by the Network Outcomes Performance Management Team.

4 Collective Risk is a measure of the total number of fatal and serious injury crashes per kilometre over a section of road, and is also referred to as the Crash Density.

5 Personal Risk is similar to the Collective Risk but takes into account the traffic volumes along the section of state highway and measures the rate of fatal and serious injury crashes per vehicle kilometre. Therefore the high traffic flows mean that the risk to the individual is lower.

7 Demonstrating the Need for Investment

7.1 Problems and Opportunities

A facilitated investment logic mapping workshop was held on the 9 April 2014 with key stakeholders to gain a better understanding of current issues and to explore the case for change for this section of SH1 between Cambridge and Piarere. The stakeholder panel identified and agreed a number of key problems that would drive and influence future investment on this section. These are set out below.

- **Problem 1:** Poor driver behaviour coupled with a sub-standard road design for its current function leads to a high crash rate along the corridor **(40%)**
- **Problem 2:** Competing priorities of access and throughput along the corridor has contributed to the crash history **(20%)**
- **Problem 3:** Future demand for the corridor is expected to exceed capacity potentially reducing the regions ability to support growth **(40%).**

In a second workshop on Benefit Mapping held on the 3 June 2014 the key benefits of addressing these problems were agreed, including:

- **Benefit 1:** Improved safety **(70%)**
- **Benefit 2:** Improve/maintain economic efficiency along SH1 and SH29 corridor **(30%)**.

The ILM Problem and Benefit Maps are included in Appendix B. It should be noted that the stakeholders gave the safety benefit a significantly higher weighting as there is evidence of deaths and serious injuries occurring now whereas the efficiency problem is a future anticipated problem.

The following sections provide an overview of each of the problems in turn, briefly highlighting the key evidence of the problems, consequences and the significance of each in terms interactions with key policy and strategy directions.

7.1.1 Problem 1: Poor driver behaviour coupled with a sub-standard road design for its current function leads to a high crash rate along the corridor.

This problem is concerned with the high number of and rate of deaths and serious injuries resulting from crashes occurring along this section. These are primarily caused by sub-standard design of the state highway (accesses, intersections and bends) as well as driver mistakes. In terms of driver mistakes the stakeholder panel discussed poor decision making, observation and judgement.

As well as the number and rate of deaths and serious injuries, the injury crashes also result in closures of the road which in turn can disrupt the movement and reliability of journey times for the movement of people and freight.

The Collective Risk[6] along this section of SH1 is in the Medium-High risk band. Daily traffic volumes along this section are currently around 15,000 vehicles (AADT[7]); as such the Personal Risk[8] is in the Low risk band.

The crash history and key contributory factors have been identified using recent reports via the Crash Analysis System (CAS) for the 5 year period between 2010 and 2014 inclusively (Table 7-1). This analysis is for the section of SH1 between the tie in at the southern end of the Cambridge section of the Waikato Expressway and the SH29 intersection.

Over the 5 year period there have been 84 crashes, of which there were 5 fatal crashes, 3 serious injury crashes, and 27 minor injury crashes. The locations of these crashes are shown in Figures 7-1 and 7-2.

6 Collective Risk is a measure of the total number of fatal and serious injury crashes per kilometre over a section of road. Collective Risk is also referred to as the Crash Density.
7 Annual average daily traffic (AADT)
8 Personal Risk is similar to the Collective Risk, but takes into account the traffic volumes along the section of state highway and measure the rate of fatal and serious injury crashes per vehicle kilometre.

A number of key factors have been noted from the CAS records:

- **Loss of control on bends and straights** features strongly in the crash records, accounting for 42% of all crashes and 49% of injury crashes
- 43% of crashes involved a vehicle striking a roadside object (for example fences, ditches, trees, signs, cliff banks etc.)
- **Crossing and turning traffic** was reported as a factor in 19% of all crashes and 23% of injury crashes. Of the 26 intersection crashes, 15 occurred at the SH1/29 intersection. There were also 6 crashes at the SH1/Hydro Road intersection.
- **Crashes generally occur along the entire length of the section** (Figures 7-1 and 7-2) with around 70% of all crashes occurring mid-block and 30% at intersections
- Around 67% of all crashes involved a car, with approximately 9% involving trucks
- Weather and darkness do not feature as major factors, with around 71% of crashes occurring during day-light hours and/or 76% in dry conditions
- In terms of crash factors, **poor driver decision making** (poor judgement and observation) was a factor in approximately half of all crashes and fatal and serious injury crashes. Driving error and mistakes featured in up to 50%+ of crashes
- Travelling too fast for the conditions was a factor in up to a quarter of fatal and serious injury crashes, with fatigue attributing to over 37%.
- The road and roadside environment plays a part in the severity of the crashes and there is scope to reduce DSIs with a more forgiving environment.

There have been 5 fatal crashes in the five year period 2010 to 2014. There was one fatal crash occurring once in each of the years 2010 and 2011, and three fatal crashes occurring in 2014. While the fatal crashes were spread along the route, **three fatal crashes involved a vehicle crossing the centre line**. One of these three was at a passing lane. Of the fatal crashes 3 were traveling north and 2 traveling south.

The three serious crashes occurred in 2011, 2012 and 2013.

For the fatal and serious crashes the following observations can be made:

- Seven (7) of the 8 **fatal and serious** injury crashes have occurred at **midblock locations**.
- Two of the five fatal crashes involved vehicles colliding **head-on on a straight** with one other fatal a **head-on collision on a bend**.
- Two of the serious crashes (25% of F&S crashes) were loss of control on a left hand bend.
- Seven (7) of the 8 F&S crashes occurred in the **day with dry and fine** conditions.
- Seven (7) of the 8 F&S crashes involved a car, there was also one pedestrian crash and two crashes involved a SUV/Van. One truck was involved in a crash but it was not at fault.

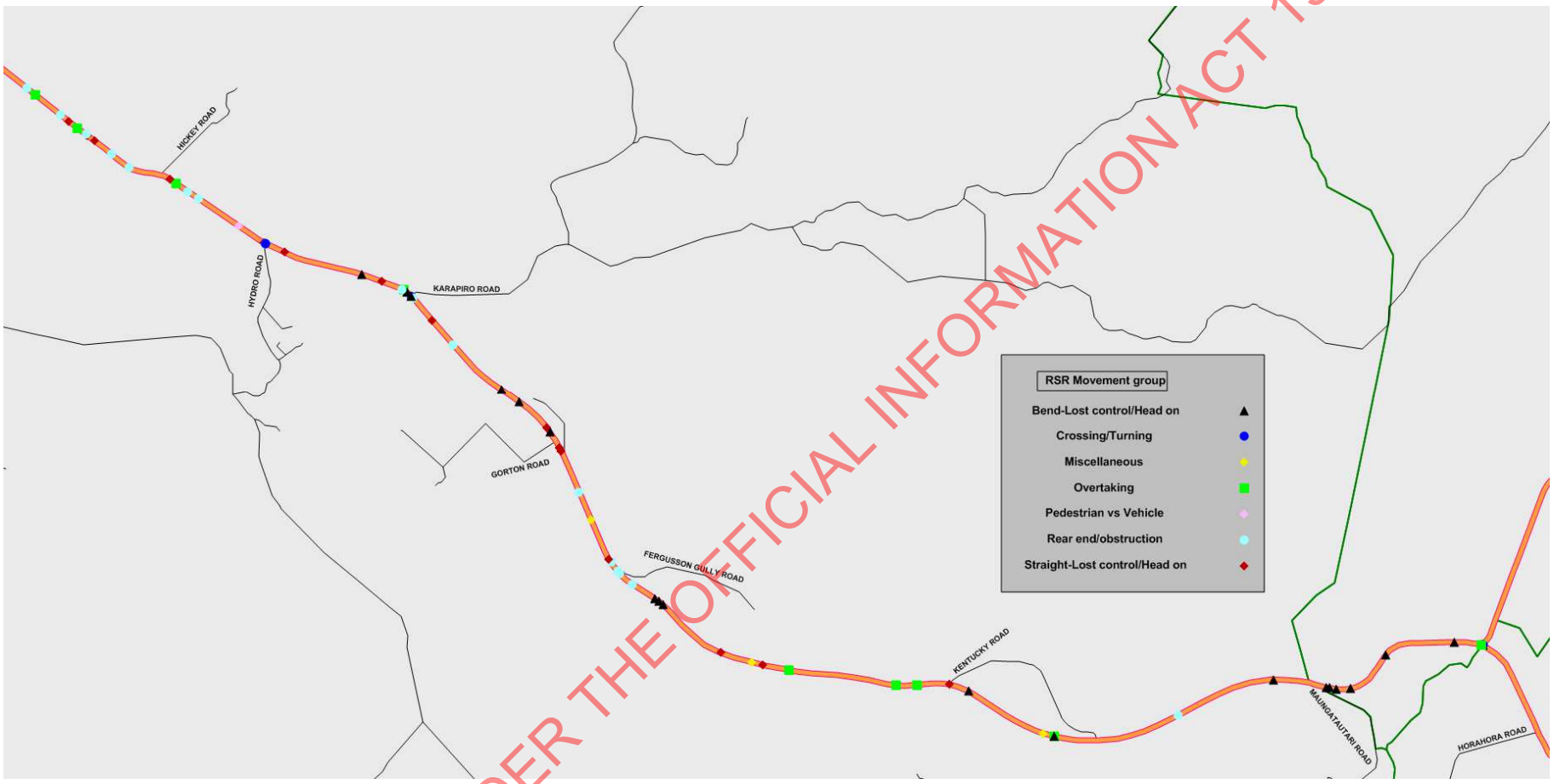


Figure 7-1: All Crashes by Type, 2010 to 2014

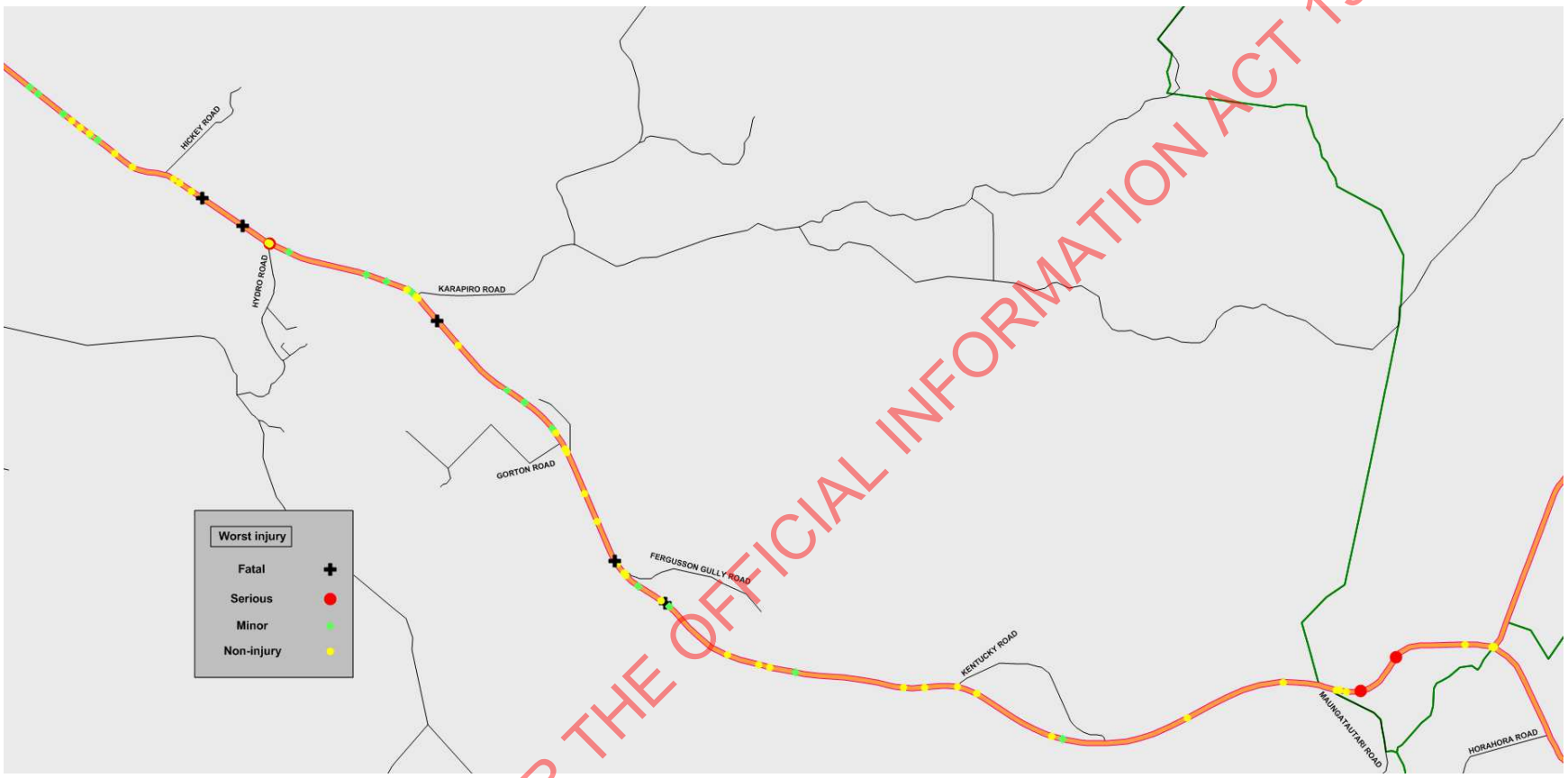


Figure 7-2: Injury Severity of Crashes, 2010 to 2014

Table 7-1: Summary of Crash Types and Factors, 2010 to 2014 inclusively

Key Crash Types and Factors	Total Crashes (%) *Includes injury and non-injury*	Total Injury Crashes (%)	Rural SH in NZ
Crash Movement			
Overtaking	9 (11%)	4 (11%)	3,345 (10%)
Straight road – lost control / head on	**15 (18%)**	**7 (20%)**	**5,984 (18%)**
Bend – lost control / head on	**23 (27%)**	**10 (29%)**	**10,497 (32%)**
Rear end / obstruction	**17 (20%)**	5 (14%)	**10,185 (31%)**
Crossing / turning traffic	**16 (19%)**	**8 (23%)**	2,238 (7%)
Other	4 (5%)	1 (3%)	804 (2%)
Intersection / mid-block			
Intersection	26 (31%)	10 (29%)	5,431 (16%)
Mid-block	**58 (69%)**	**25 (71%)**	**27,622 (84%)**
Environmental factors			
Light	**60 (71%)**	**25 (71%)**	**22,510 (68%)**
Dark	24 (29%)	10 (29%)	10,485 (32%)
Wet	20 (24%)	7 (20%)	11,052 (33%)
Dry	**63 (76%)**	**28 (80%)**	**21,943 (67%)**
Vehicles involved *(Note more than one vehicle type can be recorded in each crash)*			
Cars	99 (67%)	44 (70%)	36,817 (78%)
Van/Ute/SUV	36 (24%)	15 (24%)	5,422 (15%)
Trucks	13 (9%)	4 (6%)	4,561 (13%)
Struck an Object	**36 (43%)**	**15 (43%)**	**15,967 (48%)**
Key crash factors *(Note each crash may have more than one factor)*			
Too fast	10 (5%)	4 (5%)	**5,079 (15%)**
Failed to give way/stop	**16 (9%)**	**8 (10%)**	2,116 (6%)
Failed to keep left	5 (3%)	5 (6%)	783 (2%)
Overtaking	5 (3%)	4 (5%)	942 (3%)
Incorrect lane/position	7 (4%)	-	**8,083 (24%)**
Poor handling	**25 (16%)**	**7 (9%)**	**10,249 (31%)**
Poor observation	**35 (19%)**	**16 (20%)**	**9,866 (30%)**
Poor judgement	12 (6%)	**8 (10%)**	**4,908 (15%)**
Fatigue	**14 (8%)**	7 (9%)	3,209 (10%)

Bold Most prevalent factors and types in each category

Over represented compared to national rural state highways

When comparing the crash record of this section of SH1 with other rural state highways across NZ it can be seen that there are certain crash types or factors that stand out as being over represented.

- The rate of crossing/turning crashes is notably higher than elsewhere in NZ, with 19% of all crashes on this section compared to 7% over the rest of the country. There were also 31% of all crashes at intersections, compared to 16% over the rest of the country. This would indicate that crossing and turning is an issue that needs to be addressed.

- Crashes in the dry are over represented (or crashes in the wet are under represented). Crashes in the light and in the dark are similar to the rest of NZ. Environmental factors would not appear to be an issue.

- Vehicle type appears to indicate that crashes involving vans, utes and SUVs are over represented. Truck crashes and car crashes are below the rural average. The underlying causes for the van/ute/SUV crash rate should be investigated further.

The suggested CLOS safety performance is a 4 Star KiwiRAP rating for a high volume national route. In addition targeted prevention of fatal and serious crashes, as well as protection from harm are outcomes suggested for this route classification. There is hence a case for change to make this corridor more forgiving to drivers making mistakes, alongside actions to improve driver behaviours and road use.

7.1.2 Problem 2: Competing priorities of access and throughput along the corridor has contributed to the crash history.

Similarly this problem is concerned with the number and rate of deaths and serious injuries resulting from crashes, though this time focussing on the competing use and demand for this section of SH1. In particular this relates to the conflicts that exist between long distance inter-regional traffic and local users of the state highway, and the number of deaths and serious injuries that these can result in.

As a strategic route, SH1 caters for long distance traffic including mainly freight, commuter and tourist traffic. In 2013 this section carried approximately 15,000 vehicles daily (AADT) including around 1,600 heavy vehicles (10.9%)[9].

However, with the large number of intersections and accesses serving the different land-uses located along this section, including access to the Waikato River/Lake Karapiro, there is a significant level of turning traffic. There are approximately 10 at-grade intersections along this section that accommodate different levels of turning traffic volumes between 50 and 800 vehicles per day (Table 7-2).

As stated under Problem 1 above, around 30% of all crashes along this section occurred at intersections (Table 7-1). Similarly crossing and turning traffic was reported as a factor in a third of fatal and serious injury crashes along this section, and 20% of all crashes.

School buses, post vans, as well as farm vehicles also regularly stop at the numerous properties along this section, further exacerbating the safety risk for motorists travelling along this section.

[9] NZ Transport Agency State Highway Traffic Volumes 1975-2013 http://www.nzta.govt.nz/resources/state-highway-traffic-volumes

Table 7-2: Approximate Turning Volumes at Intersections

Intersection	Approximate Turning Volumes (Vehicles per day)
Hickey Road	<100
Hydro Road	<800
Karapiro Road	>500
Gorton Road	<50
Tunakawa Road	<100
Fergusson Gully Road	<50
Moana Road (access to lake reserve)	Unknown
Kentucky Road	<100
Maungatautari Road	Unknown
SH29 Intersection	>6,000

In summary the above factors lead to a significant risk in terms of rate and severity of crashes along this section. Crashes also contribute to a risk of closure that will affect the reliability of the route in terms of journey times for the movement of people and freight.

7.1.3 Problem 3: Future demand for the corridor is expected to exceed capacity potentially reducing the region's ability to support growth.

This section of SH1 currently carries daily traffic volumes of around 15,000 vehicles[10] (AADT). This includes around 1,600 heavy vehicles each day, representing over 10% of the total traffic volume. This high traffic volume reflects the important role this section of SH1 has in linking SH1, SH1B, the Cambridge urban area and its surrounds in the north with SH1 and SH29 to the south.

Based on the daily traffic volumes (AADT) recorded since 2009 it can be seen that traffic volumes have remained stable prior to 2012 (Table 7-3). Since 2012 traffic volumes have increased, and in 2014 alone all traffic grew by 3.8%, including 8.1% growth in HCVs. Further growth is expected, initially as a result of drivers choosing to use the new Waikato Expressway over and above other routes, but also as a result of the expected population and economic growth in the upper North Island.

Table 7-3: Average Daily Traffic Volumes, 2009 to 2014 (Karapiro Telemetry Site 20)

Year	2009	2010	2011	2012	2013	2014
Annual average Daily Traffic (AADT)	14,613	14,726	14,629	14,365	14,625	15,181

Critically the typical capacity of a passing lane merge is 1,200vph to 1,400vph, and this will have a significant impact in breaking the normal flow of traffic. This is starting to occur at peak times now, with current peak hour flows around 2,600vph in both directions during the afternoon peak (and greater than 1,300vph in the peak direction). Without intervention traffic conditions on this section of SH1 will deteriorate significantly during peak travel times, resulting in delays and journey times becoming unreliable for the movement of people and freight. Traffic flows during the peak hours are estimated to increase from around 1,200-1,500 vehicles per hour[11] (vph) currently to around 1,600-2,000vph in 2030, and 1,900-

[10] NZ Transport Agency State Highway Traffic Volumes 1975-2013 - Karapiro, Telemetry Site 20.
[11] Peak hour flows are estimated based on assuming 8 to 10% of the daily volume.

2,300vph in 2040. The typical lane capacity of a rural state highway is between 1,600 and 1,800vph, and predicted flows will be approaching this in the medium and longer terms.

The CLOS target outcomes suggest 100km/h operating speeds for general traffic and 90km/h for freight traffic, together with consistent and improving travel times. The future growth in traffic volumes clearly puts pressure on this section of the highway. These CLOS outcomes clearly cannot be achieved and will worsen over time.

Table 7-4: Current and Future Traffic Volumes

	2014	2020 (with WEX)	2030 Estimated	2040
Estimated Average Daily Flow (vpd)	15,000	18,000	20,000	23,000
LOS[12]	C	C/D	D	D/E
Estimated peak hour flow (vph)	1,200–1,500	1,300–1,800	1,600–2,000	1,900–2,300
Lane capacity	1,600 to 1,800vph			
Passing lane merge capacity	1,200 to 1,400vph			
Ave Speed (km/h) in peak hour	80	75	65	60
Ave Time to Travel Section (min) in peak hour	12.7	14	17	18

Based on traffic demands, during peak times it is estimated that this section of SH1 currently operates at an average level of service (LOS) of C[13]. In peak periods the dominant traffic flow experiences worse conditions however, and this LOS is summarised[14] in Table 7-5. In general the LOS is influenced by the on-road capacity, and LOS improves in the midblock passing lanes and worsens in the midblock 2 lane sections. Afternoon peak periods have a lower level of service than morning peaks, whilst interpeak periods are better than morning peak periods.

[12] LOS C is defined as where the operational condition of this road "*is in the zone of stable flow but most drivers are restricted to some extent in their freedom to select their desired speed and to manoeuvre within the traffic stream. The general level of comfort and convenience declines noticeably at this level.*"
Level of Service D describes operational conditions "*that are close to the limit of stable flow and approaching unstable flow. All drivers are severely restricted in their freedom to select their desired speed and to manoeuvre within the traffic stream. The general level of comfort and convenience is poor and small increases in traffic flow will generally cause operational problems.*"
Reference: State Highway Geometric Design Manual Sections 2: Basic Design Criteria (April 2003)

[13] Broadly a LOS C is defined as where the operational condition of this road "*is in the zone of stable flow but most drivers are restricted to some extent in their freedom to select their desired speed and to manoeuvre within the traffic stream. The general level of comfort and convenience declines noticeably at this level.*" Reference: State Highway Geometric Design Manual Sections 2: Basic Design Criteria (April 2003).

[14] LOS data from NZ Transport Agency's EfficiencyNet

Table 7-5: Level of Service on SH1 between Cambridge and Piarere

Time period	Eastbound	Westbound
AM peak period	B, C	C
PM peak period	B, C, D	C, D
Interpeak period	B, C	B, C

Future forecasts using the Waikato Regional Traffic Model (WRTM) indicate that daily traffic volumes are forecast to increase to around 18,000 vpd by 2021; this assumes the completion of the Waikato Expressway. By 2041 traffic levels of up to 23,000 vpd (AADT) are forecast based on the WRTM[15]; at this point the level of service is estimated to be reduced to a LOS D[16]. Journey times are anticipated to worsen from the current peak hour time of 12.7min to 18min by 2040.

7.2 Performance Relative to Customer Levels of Service

Based on the One Network Roading Classification target CLOS, the performance of this section of SH1 currently does not meet that for a national high volume route. The gaps in CLOS that exist between the desired outcomes and the actual performance are as follows:

- **Safety performance:** The 3.1 to 3.4 Star range in KiwiRAP Star ratings is less than the desired 4 Star rating.
- **Travel time reliability and efficiency:** The CLOS outcome for this route is that the journey will be reliable and improving. This is currently not the case where delays are experienced due to the limited capacity of the passing lane merges, the conflict between through and local traffic, and the number of priority intersections along the corridor. The high number of crashes also impact negatively on journey time reliability.
- **Resilience:** Detours are available for the SH1 journey. These include local road and State highway roads
    - For the SH1 to SH29 journey Taotaoroa Road (approx. 2 km shorter but steep and windy in places) and Buckland Road (approx. 1 km longer but also steep and windy in places) are local road detours where a part of the route is affected, or a wider diversion via Morrinsville along SH26-SH27-SH24 between Hamilton and the Kaimai range (approx. 7 km longer) where the whole route is affected, or SH27 and SH2 between Auckland and the Kaimai range. Taotaoroa Road and Buckland Road are in places very steep with sharp curves and not suitable for overdimension or overweight vehicles. Travel speeds are therefore slow. Whilst the alternate route is available, it is not suitable for all traffic
    - For the SH1 journey Maungatautari Road is an alternate route on the local road network (approx. 9 km longer and steep and windy in places), and a wider diversion is along SH27 and SH26 between Hamilton and Tirau (approx. 34 km longer), or SH27 and SH2 (similar distance but has delays) between Auckland and Tirau.
- **Speeds:** The desired outcome of high, consistent speeds of 90km/h for freight and 100km/h for other traffic is not achieved at all times and are expected to deteriorate further with increasing traffic flows.
- **Amenity:** The quality of the journey is influenced by the topography with the corridor passing alongside Lake Karapiro and on the toe of the Karapiro hills. The ride comfort is generally good though there are locations where out of context curves are an issue.

[15] SH1 Cambridge to Piarere Safe System Project Feasibility Report (2014).

[16] Level of Service D describes operational conditions "that are close to the limit of stable flow and approaching unstable flow. All drivers are severely restricted in their freedom to select their desired speed and to manoeuvre within the traffic stream. The general level of comfort and convenience is poor and small increases in traffic flow will generally cause operational problems."

- **Accessibility:** The provision of highly engineered access without impedance has not been consistently provided along this section of the journey, where some intersections do not have on-line turning facilities, and all driveway accesses have direct access to the state highway for all turning movements. The ease with which traffic is able to connect between SH1 and SH29 is also deficient due to the priority intersection arrangement between these two strategic routes.

Table 7-6: SH1 Customer Level of Service Performance

	Desired Outcome	Actual Performance	Performance Gap
Safety performance	4 Star KiwiRAP	3.1 to 3.4 Star KiwiRAP	0.6 to 0.9 Star KiwiRAP
Travel time reliability and efficiency	Reliable and improving At 100km/h travel time is 10.2min	12.7min in 2014 and forecast to worsen to 18min in 2040	2.5min in 2014, worsening to almost 8min in 2040
Speeds	100km/h, 90km/h for freight	Varies, 80km/h in peak hour in 2014, forecast 60km/h in 2040	20km/h lower than desired in 2014, worsening to 40km/h in 2040
Resilience	Alternative is always available	Alternative is always available, although level of service is less than state highway standard	Acceptable – however, impacting on the travel time reliability of the route
Amenity	Journey quality responds to topography, generally good ride comfort	Journey quality responds to Lake and hills. Ride comfort generally good.	Acceptable
Accessibility	Grade separated interchanges on RONS, otherwise widely spaced intersections	Intersections widely spaced, although clustered in areas and with safety issues	Unsuitable intersection form and spacing.

The CLOS assessment highlights the case for change and the gaps between the desired CLOS outcome and the current journey conditions. With the forecast step change in traffic anticipated on the Waikato Expressway this section of the corridor between Cambridge and Piarere has the potential to undermine the benefits from investing in the Expressway due to an erosion of travel time savings gained on the journey north of Cambridge. For drivers heading south there will be a significant change in the road environment coming off the Waikato Expressway to the existing road. Without intervention, traffic conditions on this section of SH1 will deteriorate significantly, resulting in delays and journey times becoming unreliable and longer for the movement of people and freight. The increased traffic volumes will also increase the risk of crashes occurring and people being killed and injured.

This worsening level of service, both level of safety service and congestion due to increased traffic flows, leads directly to a decrease in journey time reliability and also journey time over this 16km length of state highway.

The anticipated growth in traffic is further supported by the growth in the regional economy. Statistics New Zealand figures show that the Waikato region is experiencing above average growth rates in Gross Domestic Product when compared to North Island and New Zealand. This is displayed in Table 7-7, where the Bay of Plenty region and Auckland are also shown for comparison, both of which are also growing at rates above average. This further supports the importance of good transportation linkages between the Auckland-Waikato-Bay of Plenty to support economic growth.

Table 7-7: Waikato GDP for year ended March 20014

Region	GDP	Population	GDP per capita	Share of national	Percentage change in GDP

	$(million)	Number	$ per person	GDP %	2009-14 $(million)
Waikato	20,576	427,800	48,098	9.0	23.8
Bay of Plenty	11,862	281,000	42,213	5.2	23.2
Auckland	81,186	1,510,200	53,759	35.3	24.7
Total North Island	176,016	3,425,100	51,390	76.6	21.1
Total New Zealand	229,718	4,476,300	51,319	100	22.4

The ILM workshops and the subsequent review of the evidence base again confirmed that the case for change for SH1 between Cambridge and Piarere. The key problems agreed by stakeholders in relation to safety and future efficiency are supported hence work has progressed to considering alternatives and options to respond to the problems.

Before considering programme alternatives and options, it is important to be clear around the uncertainties that exist and any assumptions being made.

7.2 Issues and Constraints

A number of issues and constraints have been identified through the workshops with the stakeholders, as well as though historical information and knowledge. These are important to understand the nature and timing of any issue and constraint, how these might influence the development of the emerging programme for improving this section of SH1, and/or how others are affected.

'Issues' are uncertainties that this PBC is not in a position to resolve but must work within the context of whereas 'constraints' represent the bounds within which this PBC has been undertaken. The key issues and constraints are set out in Tables 7-8 and 7-9 and have been used to help inform development of programme alternatives and options to respond to the identified problems.

One key issue to note is that this Programme Business Case is being prepared in advance of the Business Case for the Hamilton to Tauranga Corridor (SH1/SH29). Therefore there are issues, interactions and possible sensitivities relating to travel demand for the corridor, and in particular freight demand along SH1 that might affect the development of a preferred programme for SH1 Cambridge to Piarere.

Table 7-8: Issues Log

Factor/Issue	Time	Uncertainty	Impact on programme	Comments
Factors affecting demand				
Change in government strategy – decrease in investment	3-year election cycles	Reasonably foreseeable	Medium	Government Policy Statement in Land Transport may alter future priorities in expenditure with allocation in activities not directly related to infrastructure may put pressure on the capacity of the route to provide safe or efficient transport. This may delay the implementation of interventions.
Ruakura inland port, Hamilton	Up to 20 years, and beyond	More than likely	Medium	The Ruakura inland port on the east of Hamilton, and with direct access to the Waikato Expressway, has been given approval for a Hamilton City plan change by the Environmental Protection Authority for 600Ha of commercial and residential development. The transport hub will over time attract and distribute both road and rail traffic, with SH1 playing an important inter-regional link.
Traffic Levels	2025 onwards	Likely	High	The future prediction of future growth in travel demand as well could impact on the timing of an intervention. This PBC currently uses forecast data but monitoring will need to be undertaken to ensure action is taken in a timely manner.
Factors affecting supply				
Upgrade of rail connection between Hamilton and Tauranga	Unknown	Hypothetical	Medium	On-road freight demand may reduce, impacting on timing when efficiency interventions may be required.
Upper North Island Freight Story initiatives	Approx. 10 years	More than likely	Low	Complimentary strategic responses are expected for SH1 to realise desired benefits. A collaborative approach by stakeholders is anticipated.

Factor/Issue	Time	Uncertainty	Impact on programme	Comments
Impact of the completion of the Waikato Expressway	2019/20	Committed	High	The programmed completion of the Expressway will finalise the investment and eliminate the final bottlenecks on the route. Significant travel time savings are anticipated, and the result for freight haulage is expected to be savings in transportation costs. Freight traffic currently using SH2 and SH27 between Auckland and Tauranga are anticipated to transfer onto the expressway, although the impact of this change has been difficult to quantify.
Factors affecting cost				
Preferred scheme for the SH1/29 intersection upgrade	10 years	More than likely	High	High cost SH1/29 grade separated intersection upgrade may impact on the potential realignment of SH1.

Table 7-9: Constraints Log

Constraints	Timescale	Potential Level of Impact on Programme
The areas adjacent to the SH1 on this section present a topography and environment that could make certain improvement works expensive. For example to the northern side there are several sections of steep hills immediately adjacent to the state highway. To the west this section of the state highway passes close to Lake Karapiro.	At present	Med
This section of SH1 also runs through areas that are considered culturally, environmentally and possibly ecologically sensitive. These could affect the programme development in terms of costings, acceptance, timescales, consenting, technical engineering etc.	At present	Med-High

8 Stakeholders

8.1 Consultation and Communication Approach

Engagement with the key stakeholders collectively has been important as many of the problems, potential benefits and programme development activities have required an integrated and collaborative approach.

The problems and benefits relating to this section of SH1 corridor, along with the identification and assessment of alternative programmes affect a number of different organisations and users.

In terms of informing the development of the business case key stakeholders were invited to participate in the problem definition, benefit mapping and the alternatives and strategic options workshops. The key stakeholders included:

- NZ Transport Agency – Highways Network Operations
  - Transport Planning
  - Road Safety
  - Network Operations
  - Project Services
- NZ Transport Agency – Planning & Investment
- Waikato Regional Council
- Road Transport Association
- Freight Logistics Action Group
- Waipa District Council
- South Waikato District Council
- NZ Police
- iwi: Ngāti Raukawa
- iwi: Puawai
- iwi: Ngati Koroki Kahukura
- iwi: Ngati Haua

All organisations attended the initial ILM problem definition and/or the benefit mapping workshops. The Alternatives and Strategic Options workshop was attended by those who were directly influential in this section; namely NZ Transport Agency, Waikato Regional Council, Waipa District Council, the Police and the freight representatives.

KiwiRail were unable to resource a suitable representative to attend the workshops although there is a desire from KiwiRail to be kept updated on the project.

9 Programme Development and Assessment

The identification of the high level Programmes has taken place through a process involving a number of stakeholder workshops and programme assessments. Primarily focussed on achieving the short term safety benefits and the medium-long term efficiency benefits the assessments at this stage have made best use of existing information and analysis. For example, this primarily included application of the High Risk Rural Road Guide (HRRRG), and factual information and analysis from the previous SH1 Cambridge to Piarere Project Feasibility Reports and the SH1 Strategic Corridor Study (though not the conclusions or recommendations directly).

The development and assessment of options for the SH1 Cambridge to Piarere Improvements has been achieved through three key steps.

Step 1: The first step involved an Alternatives and Strategic Options Workshop. Following on from the ILM workshops this workshop set out to **develop a range of programmes** with the stakeholders and assess these against their potential to achieve the agreed benefits. A shortlisted programme is agreed upon by the stakeholder for further development and testing.

Step 2: The second step involves **additional analysis** of the **short-listed programme** to determine what the shortlisted programme looks like in terms of strategic options/actions required to deliver the benefits. The analysis also set out to confirm that the benefits can be achieved through these actions – and hence confirms the recommended programme (Section 9.3).

Step 3: Finally, based on the above two steps a **recommended programme** is confirmed (which may differ from the programme shortlisted in the workshop). The recommended programme was put forward to be discussed and confirmed at a Preferred Programme Workshop (**Sections 9.3** and **10**).

9.1 Programme Development

An Alternatives and Strategic Options Workshop was held on 10 September 2014 with the key stakeholders. This was a facilitated workshop to identify and consider a full range of alternative programme options to achieve the agreed investment benefits for the Cambridge to Piarere corridor. An initial assessment of each programme option was also undertaken during the workshop to identify a shortlisted programme to be taken forward for further development and assessment.

The alternatives programme options are set out below in turn together with a summary of the initial assessment as completed in the workshop with stakeholders. The initial programme assessment framework is included in Appendix C, however it should be noted that stakeholders did consider a number of other options for example relocation of boat ramps in order to reduce the local recreational access.

- **Programme 1 – Do-Minimum.** The Do-Minimum alternative represents the minimum level of activity required to maintain a minimum level of service. It does not mean the minimum level of investment required to achieve the programme outcomes.

  In this case the Do-Minimum alternative would consider routine maintenance activities and minor/low cost works aimed at maintaining customer levels of services in terms of safety, efficiency and local access. For example this might include minor works around road markings and signage, with some minor edge line and kerb corrections, and pavement re-seals. It may also consider community programmes to promote travel and safety awareness and training. This alternative would not set out to address the crash issues fully.

- **Programme 2 – Safety Focus (On-line).** This programme is only concerned with addressing the safety problems along the corridor. In particular on the mid-block sections it looks to reduce the risk of high speed and head on impacts resulting from vehicles losing control and overtaking. In addition, given the high number of accesses and land-uses along this corridor, it is also concerned with providing safer access to and from the state highway.

Indicatively this programme would consider:

- Treatment of out of context curves to reduce loss of control on bends
- Centreline treatment to reduce cross centreline loss of control/head-on crashes
- Centreline and edge line treatment to reduce risk of crashes relating to driver fatigue, driver concentration etc.
- Treatments to improve intersection and access form to reduce risks associated with turning traffic and conflicts.

- **Programme 3 – Efficiency Focus (On-line).** Focusing only on achieving the efficiency benefits this programme considers what can be done on-line to maintain journey time efficiency and reliability whilst catering predicted future traffic volumes. This may include measures to increase capacity on the mid-blocks, provision of safe and convenient passing opportunities, and managing/rationalising access to/from the local road network.

- **Programme 4 – Off-line Local Access Roads.** This programme focusses on separating the local and longer distance inter-regional traffic with new local road infrastructure and rationalising access to/from the state highway.

- **Programme 5 – Local Access/Use Focus (e.g. Safer Turning/Reducing Conflicts).** This programme would aim to manage and reduce the conflicts related to traffic accessing to and from the local road network and land uses. This might consider interventions to provide greater protection to right turning traffic, rationalise turning movements, speed management etc.

- **Programme 6 – Do Maximum Off-line State Highway (Expressway Standard).** The Do-maximum programme relates to providing a state highway at expressway standard along an off-line alignment to address both safety and cater future predicted traffic demands safely and efficiently. The existing state highway would be retained for local access under this programme option.

Multi modal (walking, cycling, public transport) for freight rail strategic alternatives were not developed. The low level of multi modal demand does not warrant a separate strategic alternative although it is acknowledged that specific demands should be catered for within the development of the activities during the design process. Example could include safe cycling facilities on the sealed road shoulders, segregated walking and cycling facilities serving facilities or land use on the route (for example in the vicinity of Karapiro School), or safe bus stopping facilities for collecting or dropping off school students.

The issues and uncertainties identified earlier have been used to consider the programme alternatives, for example, the impact of rail. It is not known whether there will be an increase or decrease in freight rail. Also, the nature of the longer distance connections of the freight journey in the context of the SH1 Cambridge to Piarere section of the journey imply that strategic options should be developed at a higher level than this SH1 Cambridge to Piarere PBC. KiwiRail is currently undertaking a number of improvement works[17] along the ECMT rail line and this PBC does not consider a rail focussed programme. However the intention is to consider the rail/road interaction through further development stages by means of sensitivity testing.

An initial assessment of the programmes was undertaken in the workshop and a shortlisted programme identified to be taken forward for further assessment and confirmation. A summary of the Initial Assessment of Programme Alternatives considered is shown in Table 9-1, including an assessment against benefits, cost and time ranges, key risks, trade-offs and dependencies. This enable stakeholders to decide upon a shortlisted programme, which is described in Section 9.2, before further analysis and testing was undertaken.

[17] As discussed in the Hamilton to Tauranga Corridor Improvements Strategic Case

Table 9-1: Summary of Initial Assessment of Programme Alternatives

	Programme 1	Programme 2	Programme 3	Programme 4	Programme 5	Programme 6
Description	Do Minimum	Safety Focus (On-line)	Efficiency Focus (On-line)	Efficiency Focus (Off-line local roads)	Local Access/Use Focus	Do Maximum Off-line State Highway – Expressway Standard
Benefit 1 – Improving Safety **(70%)**	<5%	60% to 70%	10%	30%	20% to 30%	90%
Benefit 2 – Improve/maintain economic efficiency along the SH1 (and SH29) corridor **(30%)**	<5%	<10%	50%	50%	<5%	100%
Percentage across all benefits (Weighted)	**5%**	**50%**	**22%**	**35%**	**19%**	**93%**
Cost Range	$1M per year	$1M to $50M	$1M to $50M	$5M to $50M	$1M to $5M	$200M to $400M
Timescales	Per Annum	3 to 6 years	3 to 10 years	5 to 15 years	3 to 6 years	8 to 12 years
Key Risks Key: Low Medium High/Medium-High						
• Safety problem gets worse	High/Medium-High		High/Medium-High	High/Medium-High	Medium	
• Efficiency would deteriorate in the future	High/Medium-High	High/Medium-High			High/Medium-High	Medium (Short/medium term)
• Reputation – not addressing the problems	High/Medium-High	Medium (Efficiency & Safety)	High/Medium-High (Safety)	High/Medium-High	High/Medium-High (Safety)	High/Medium-High (Short term safety)
• Not achieving the wider benefits of the WEX	Medium	Medium	Medium	Medium	Medium	
• Not achieving shift of traffic from SH27 & SH2	Medium	Medium			Medium	
• Inconsistency with the WEX in place	Medium	Medium	Medium	Medium	Medium	
• Potential crash migration		Medium				
• Risks/acceptance of restricted local access		Low	High/Medium-High		High/Medium-High	Low (Short term only)
• Costs and funding availability		Low		High/Medium-High	Low	High/Medium-High
• Environmental and cultural impact risks				High/Medium-High		High/Medium-High
• Technical challenges of surrounding terrain				High/Medium-High		High/Medium-High
• Additional maintenance costs		Medium		Medium		High/Medium-High
Key Trade-offs	• Safety • Efficiency • Freight efficiency • ONRC LOS	• Commercial objectives • Wider safety • Freight efficiency	• Safety	• Maintenance costs • Safety	• Safety • Wider safety • Freight efficiency • Efficiency	• Other investments opportunities • Environment
Key Dependencies	• Police enforcement • Maintenance programme	• Timing of WEX • SH1/SH29 intersection improvements	• SH1/SH29 intersection improvements	• Land & consenting • Agreement with other councils	• Land & consenting • Agreement/teaming with other councils	• SH1/29 intersection form • Land & consenting
Ranking	6	1	1	3	4	2

9.2 Shortlisted Programme Option

Based on this initial assessment of programme options the stakeholders considered Programme 6 (Do Max offline) and a combination of Programmes 2 & 3 (Online Safety & Efficiency) to be best performing in terms of delivering the agreed benefits.

The stakeholders favoured the combined on-line programme (Programmes 2 & 3) as they felt it would achieve around 60% to 70% of the safety benefits, along with 50% the efficiency benefits through on-line improvements. In particular the scope to address many of the key safety problems in the short term was a critical factor.

By keeping the improvements on-line the initial expectation of the stakeholders was that the investment cost could be kept within the range of $20 million to $100 million. The wide range reflects the uncertainty at that stage as to exactly what is needed to achieve the benefits, that is whether barrier treatment is required on the centreline and/or edge lines, and whether major intersection improvements are needed. Notwithstanding this, the cost range was seen to be considerably lower than the off-line state highway programme option (Programme 6) which was at that time expected to be from $200 million to $400 million. Even though Programme 6 is expected to deliver a higher level of benefits for safety and efficiency (90% to 100%) the stakeholders felt in the workshop that the shortlisted programme offers better value for money. It was also noted that the timescales associated with Programme 6 were 10 to 15 years, which meant that the safety problems would not be addressed in the short term under Programme 6 alone.

Therefore the short-listed programme agreed to be taken forward for further assessment was the combination of Programmes 2 & 3. The cost range for this Combined Programme 2 & 3 was at the time updated to be between $50 million and $100 million.

Additional assessment of Shortlisted Programme was carried out and is summarised in Table 9-2 and a recommended programme developed. Investment objectives.

9.3 Assessing the Shortlisted Programme

Additional assessment of the shortlisted programme was then carried out in order to develop up a recommended programme. The shortlisted programmes were assessed to:

- gain a better understanding of the problems and benefits
- based on this understanding, determine what the shortlisted programme looks like in terms of strategic options/actions required to deliver the benefits
- confirm that the benefits can be achieved through these actions
- confirm a recommended programme and the core activities that will be required to deliver it – noting that this may vary from the short-listed programme.

The assessment included testing Combined Programme 2 &3 against the benefits sought for the corridor:

- Benefit 1 – Safety
- Benefit 2 – Efficiency

The assessment of the shortlisted programme is set out below:

9.3.1 Benefit 1: Safety

To identify and assess what the right actions are to take and when, it was important to better understand the nature and scale of the safety problems and potential benefits. Analysis of the reported crashes[18] in terms of crash types/movements involved was undertaken, better understanding why and where these are occurring. Based on the crash data is was evident that the crash trends varied along the route, and on this basis the strategic options and actions have been considered across four sections (Figure 9-1):

[18] For this stage of the Programme Business Case, CAS data for 2009 to September 2014 was used.

- Waikato Expressway tie-in (approx. 1km north of Hickey Road) to approx. ½ km south of Hickey Road
- South of Hickey Road to Kentucky Road
- Kentucky Road to SH1/SH29 Intersection
- SH1/SH29 Intersection.

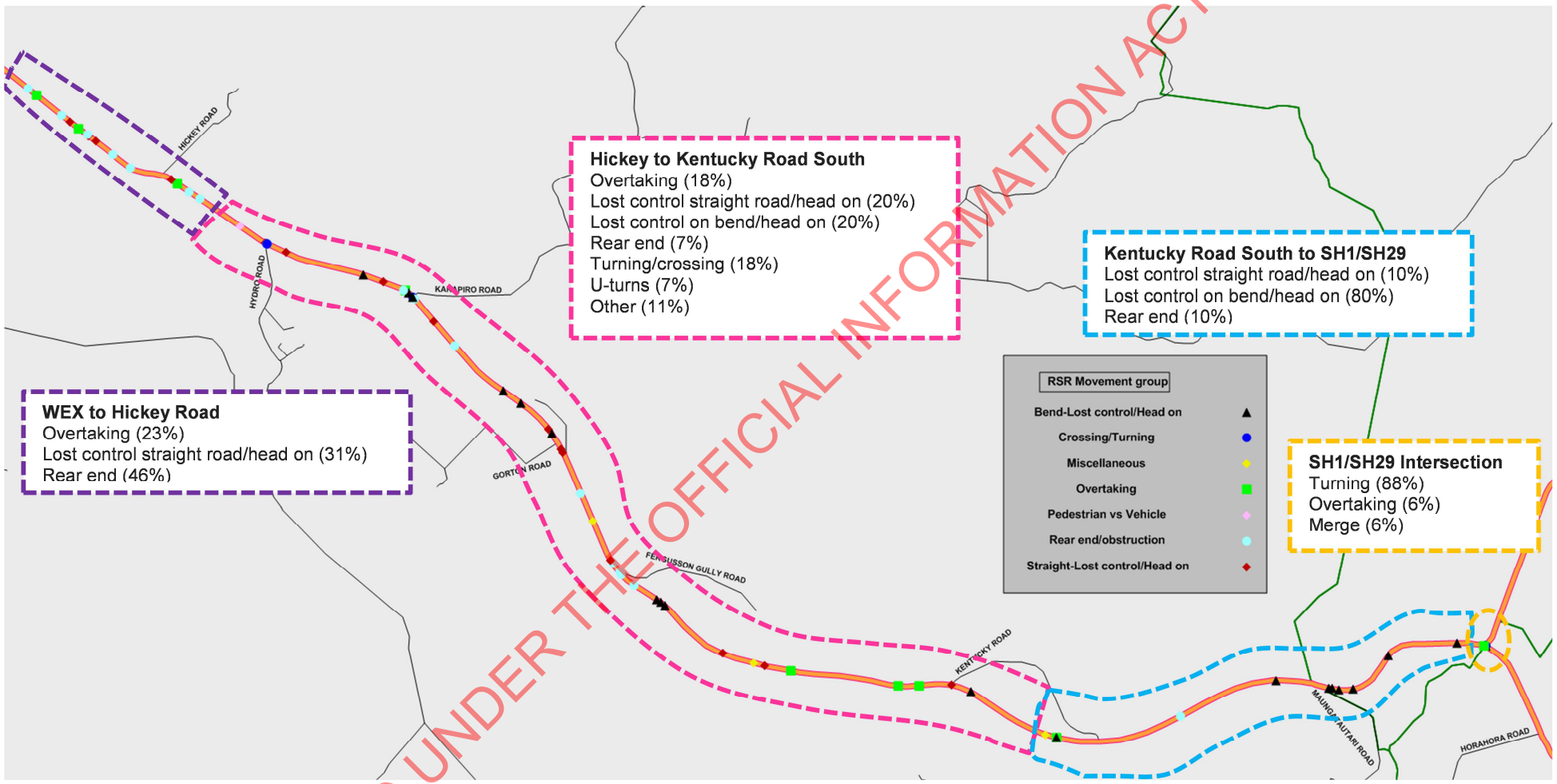


Figure 9-1: Variation of Crash Types along the corridor

Overall, two **strategic options** were identified to achieve the safety benefits taking account of the crash data and the location of these crashes along the Cambridge to Piarere section (Table 9-2).

- Reduce impact of loss of control (straights and bends)/head on crashes and overtaking crashes
- Reduce the risk and occurrence of crashes involving crossing and turning traffic at intersections and accesses.

For each of the strategic options a range of indicative interventions most appropriate for the crashes patterns reported have been identified (Appendix E – Safety Assessment). This is the basis for developing the shortlisted programme and assessing the ability of it to achieve the agreed benefits. To confirm the suitability of the indicative interventions identified the High-Risk Rural Road Guide (HRRRG) was used to determine the effectiveness of those interventions.

Appendix E shows the potential effectiveness of the programme for improving safety along this section referencing HRRRG example crash reduction rates. In summary, the expected benefits could be delivered with the range of indicative mid-block interventions, including a combination of:

- Centreline / edge line treatment (e.g. wide centreline or wire rope barrier*)
- Sealed shoulder widening
- Audio tactile profile road marking
- Review merge layouts & passing lane strategy
- Treatment of out of context curves (consistent alignment/radius)
- Intersection treatment (at- grade & grade separated)
- Rationalise of accesses with local access roads (with potential trade-off and acceptance issues relating to local users and providing turn-around facilities)
- Restricted right turns (with potential trade-off and acceptance issues relating to local users and providing turn-around facilities)
- Speed management on approaches.

Further analysis was carried out on these safety initiatives to determine how effective they might be and provide guidance on a preferred approach. Over a 10 year period, a widened centre line without a wire rope barrier would return the greatest value for money investment with a benefit cost ratio greater or equal to 1.0, whilst conversely the initiatives which included a wire rope barrier returned very low BCRs and hence a low return on investment.

A similar exercise was undertaken for intersection safety, where the intersections on SH1 between Cambridge and Piarere were tested with the High Risk Intersection Guide (HRIG) against the four HRIG safety strategies (see Appendix E). Hydro Road and SH1/29 intersections are both High Risk intersections in accordance with the HRIG due to both the Collective Risk and the Personal Risk being classified as Medium-High to High. Karapiro Road has a Collective Risk of Medium and therefore is not classified as a High Risk intersection.

The analysis shows that the highest risk intersections have safety performance that varies dependent on the safety treatment applied:

- **Hydro Road:** This intersection has a Collective Risk of Medium-High and a Personal Risk of High, with a resulting High Risk classification. The recommended treatment philosophy is Safe System Transformation. There are benefits however to carrying out relatively low cost (around $0.3 million) short term improvements in the form of intelligent active warning signs, supplemented by additional signage and markings. DSIs saved per $100 million invested are 338 over 20 years. Sensitivity testing shows that benefits increase over time.
- **Karapiro Road:** This intersection has a Collective Risk of Medium and a Personal Risk of High, and with less than 4 injury crashes in the analysis period the intersection is not a High Risk intersection. The recommended treatment philosophy is Safety Management. Short term improvements in the form of improved visibility of side roads with islands provide value for money only over a longer term however.

- **SH1/29:** This intersection has a Collective Risk of High and a Personal Risk of High, with a resulting High Risk classification. The recommended treatment philosophy is Safe System Transformation. Short term improvements in the form of well marked and well separated left turn facility with larger radius, and reduced Speed Limit (temporary) provide value for money in the longer term.

The more in depth review of the safety problems confirmed the need to consider intervention along the length of the corridor as well as particular intersections. However, to ensure the right intervention is identified, the other problems and benefits sought need to be considered alongside safety.

9.3.2 Benefit 2: Efficiency

With regards to efficiency, the stakeholders were concerned about the impact of future traffic growth on the movement of traffic, and in particular on delays and the reliability of journeys. Section 7.1.3 described the problem of increasing traffic flows especially during peak travel times, resulting in delays and longer journey times for the movement of people and freight. In most cases these types of delays are predictable by the user; hence this may not necessarily manifest in a major reduction in predictable and reliable journeys on the route.

With the increases in traffic volumes forecast on the existing state highway, this section of the state highway is unable to be resilient to unplanned events such as crashes, breakdowns, weather events and road maintenance/road works. As traffic volumes increase closer to capacity in peak conditions the greater the potential variation in travel times can be, and the more difficult it gets for users to predict delays and variability. In addition, the risk and rate of crashes and injuries can be expected to increase with higher traffic levels, and the increased driver frustration that is likely during peak times.

The additional analysis (Table 9-2) shows that by 2040 average travel speeds at peak times could reduce to as low as 60 km/h. At this speed travel times to traverse the 17km section would increase to around 18 minutes; this compares to around 12 to 13 minutes at present. At this stage it is difficult to identify exactly when traffic levels will reach a point (say between 18,000 and 20,000 vpd) where traffic flows start breaking down significantly. The figures shown in this assessment reflect current forecasts based on the WRTM, and so will need to be monitored particularly following the completion and opening of the Waikato Expressway. In an attempt to determine approximately when the capacity of this section of SH1 is likely to be exceeded, current peak hour flows[19] from 2005 to 2014 are compared to the midblock lane capacity and the passing lane merge lane capacity (see Appendix F). Current flows fall within the upper and lower limits for passing lane capacity[20], and anecdotal instances of passing lane merge issues are known. Midblock lane capacity has not yet been reached.

A range of strategic options have been considered as part of the additional analysis phase to test the ability of the existing SH1 corridor to cater for future traffic demands reliably and efficiently.

Aimed at maintaining/improving economic efficiency along the existing corridor the **strategic options / actions** include:

- Improve level of service of current 2 lane carriageway with passing lanes
- Manage conflicts with local users and side road impedance traffic
- Increase capacity (major transformational).

The first two strategic options/actions are primarily relevant to improving the existing arrangements with 2 lanes and passing lanes. The third strategic option/action considers major works such as 4 laning. As such these are two alternatives for the shortlisted programme, and represent low/medium cost and high cost alternatives.

Prior to implementing efficiency improvements along this section of the corridor, short term efficiency options were considered, but these are limited.

[19] Historical two way hourly counts at the Karapiro telemetry station, halved.

[20] The assessment has been carried out by using observed two-way AADT divided in half. WRTM all day flows have been converted to hourly flows by dividing by 10 (i.e. 10% of AADT) and then divided in half to establish a one-way flow. More detailed analysis is required for a more accurate assessment.

- **Speed management techniques:** This option considers initiatives to manage speeds along the corridor, particularly during times of higher flows when the corridor is subject to flow breakdown, delays, and unreliable journey times. Speed management through the implementation of active and variable Intelligent Transport System measures by way of regularly spaced gantry signs advising motorists of the optimum speed to prevent flow breakdown and delay was considered. A recent study[21] found that there is limited application for these initiatives in New Zealand however, especially in relation to rural state highways. The study found that 100% compliance by drivers was necessary in order for any benefits to be realised. This is therefore not a viable option.
- **Closing Passing Lanes:** The closing of passing lanes is considered as an option which eliminates the bottleneck created by the lower capacity of the passing lane merge. Whilst this is a viable alternative, it would only be beneficial for a short time period as flows increase and ultimately reach the mid-block capacity. The disbenefits of this option include increased driver frustration due to the lack of passing opportunities. It should be noted that for northbound traffic there are no passing lanes on SH29 between SH1 and the Kaimai Range, and on SH1 between Piarere and Tirau there is limited passing opportunity with only one passing lane in each direction. The benefits of this option are therefore limited.
- **Restricted/Limited Access:** An identified problem on this section of SH1 is the number of accesses between Cambridge and Piarere. Restricting or limiting access has the benefit of not impeding the flow of through traffic, leading to more reliable journey times and less conflict and thus crashes. Restricting or limiting access could include rationalising accesses, redirecting accesses along parallel service roads, or limiting accesses to left in/left out. The disbenefits of these approaches include property negotiations and purchase, stakeholder engagement and agreement, environmental and cultural risks, and an undetermined cost for the parallel new infrastructure.

It can be concluded that the scope for short term efficiency upgrades are very limited, with a range of disbenefits that potentially outweigh the benefits gained by investing in the short term efficiency improvements.

Four transformational options have been previously investigated[22] comparing on-line and off-line upgrades which provide the necessary capacity to maintain or improve the economic efficiency along the existing corridor. These options included the following and are displayed on Figure 9-2:

- **Option 1 (Blue alignment):** Upgrading the existing alignment to RoNS standards and control direct access to the highway via grade separated intersections on the northern section of the highway at SH1/29. The access to the southern section of the highway is by At-grade left turn in/out movements.
- **Option 2 (Yellow alignment):** Construction of a new RoNS standard four lane dual carriageway highway on an off line alignment with direct access to the highway via grade separated interchanges at Karapiro Road and SH1/29 intersection.
- **Option 3 (Red alignment):** Construction of a combination of upgrading the existing northern section of highway to RoNS standard and a RoNS standard four lane dual carriageway highway on and off line alignment southern section. Grade separated interchanges at Hydro Road and Karapiro Road. Construction of structures over Karapiro, Gorton Road and an underpass under the 4 laning.
- **Option 4 (Black alignment):** Hybrid of Option 1 and Option 3. The first part follows the same alignment as Option 3 and then transfers to the existing alignment (Option 1) along the Lake edge.

21 NZ Transport Agency Research Report 549 – Operating Characteristics and economic evaluation of 2+1 lanes with or without intelligent transport system assisted merging, may 2014, TDG and University of Canterbury.

22 SH1 Cambridge to Piarere Four Laning Project Feasibility Report (2011)

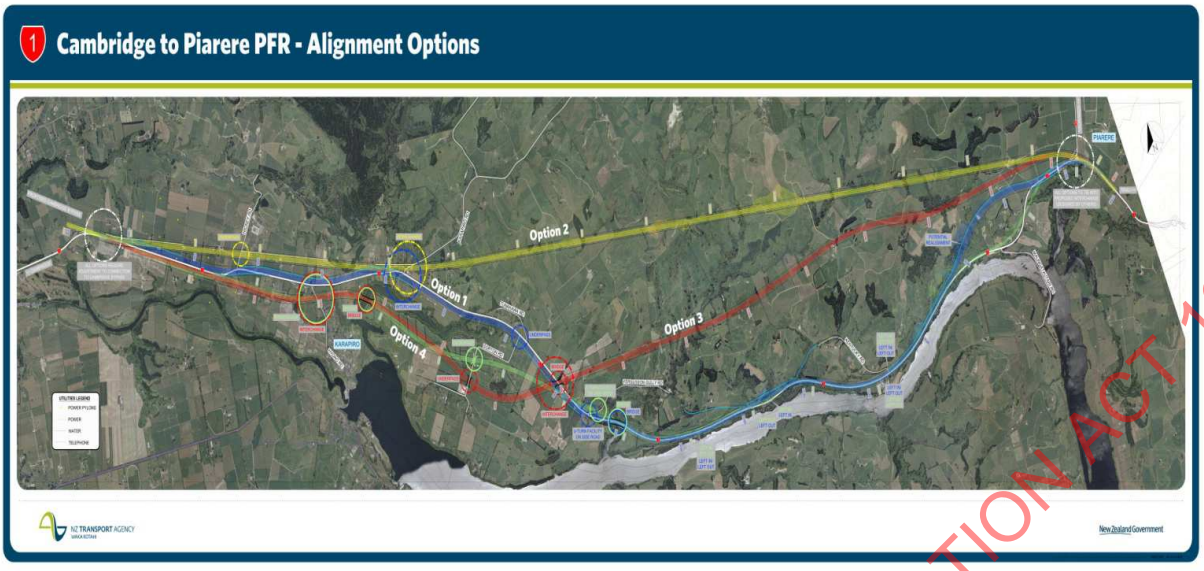


Figure 9-2: Previous PFR efficiency alignment options

The assessment of the strategic options is summarised in Table 9-2. This has not entailed any additional traffic modelling at this stage, but has drawn on information from the previous State Highway 1 Corridor Study (2011), SH1 Cambridge to Piarere Four Laning Project Feasibility Report (2011), and knowledge from technical experts involved.

Table 9-2: Efficiency Assessment of Strategic Options

	2014	2020 (with WEX)	2030 Estimated	2040
Estimated Average Daily Flow (vpd)	15,000	18,000	20,000	23,000
LOS	C	C/D	D	D/E
Estimated peak hour flow (vph)	1,200-1,500	1,300-1,800	1,600-2,000	1,900-2,300
Lane capacity	1,600 to 1,800 vph			
Passing lane merge capacity	1,200 to 1,400 vph			
Ave Speed (km/h) in peak hour	80	75	*65*	60
Ave Time to Travel Section (min) in peak hour	12.7	14	17	18
Assessment of Strategic Options				
Improve current 2 lane + passing lanes arrangement in peak hour		LOS=C/D	LOS=D	LOS=D/E
		80km/h	70-75km/h	65km/h
		12.7 min	15 min	17 min
On-line 4 Laning in peak hour			LOS=B	
			90-100km/h	
			10 min	

From the assessment the following points can be drawn:

<u>Improving the current 2 lane + passing lanes arrangement</u>

- The current travel time along this section between the WEX tie-in and the SH1/SH29 intersection is around 13 minutes.
- As traffic levels on this section increase in the future, the flow of traffic will breakdown first on passing lane merges and then later on mid-block sections. By 2030 travel speeds along the section could reduce to 65 km/h and to 60 km/h by 2040. At this stage the route would be operating at approximate LOS of D/E. This would result in journey times along this section increasing to around 18 minutes; an increase of 5 minutes over current conditions. The CLOS gap identified (see section 7.1.3) will worsen and the performance of the corridor will fall short of the ONRC High Volume National route desired CLOS outcomes.
- Under usual circumstances the delays and increased travel times will in most part be predictable by the user. However, under conditions where the flows are close to capacity during peak times the ability of this section to cater for unplanned events such as crashes, changing weather conditions (including fog and rain), and road works will deteriorate. The impact of such events on travel times and delays, and the frequency of these occurring will increase. Hence the ability of users to predict delays and travel time variability will become increasingly more difficult.
- By upgrading the current 2 lane with passing lane arrangement the impacts of traffic growth on the corridor will not be accounted for but are only offset by a few years. Increasing traffic flows will still lead to a breakdown in flow, and the conflict between through traffic and local traffic will remain. The identified problems along the corridor will continue to manifest and the benefits and outcomes sought will not be realised.

On-line 4 laning

- With this option traffic flows would run at free flow conditions during all times of the day including peak travel times. Under these conditions the impact of future traffic growth on the movement of traffic, and in particular on delays and the reliability of journeys would be negligible; a LOS of B would be expected (compared to LOS D/E under the 2 laning option).
- Under free flow conditions the travel speeds would be 90-100km/h, and the travel time to traverse this section would be around 10 minutes.
- In defining the problem statement the stakeholders were predominantly concerned with the reliability of journey times, though travel time was also an issue (investment KPIs were agreed for both). So as well as providing for reliable travel, by 2040 this option will also deliver good travel time savings over both the above 2 lane option and the Do-minimum (on average 7 to 8 minutes per journey in peak times).

Off-line 4 laning

- This option would perform in a similar way to the On-line 4-laning, although would have improved performance due to the elimination of local traffic as the existing alignment is available for this purpose.
- Flows would run at free flow conditions during all times of the day including peak travel times. The 4 lane capacity is more than able to accommodate future traffic growth. Delays are expected to be negligible. Journey reliability is expected to be better than the On-line 4 laning with free flow speeds at 100km/h. A LOS of A or B would be expected.

Table 9-2 indicates that with no intervention, it is anticipated that the journey between Cambridge and Piarere will take 5 minutes longer in 2040 that it currently does. This needs to be considered in light of the current investment to increase shorten travel time between Auckland-Hamilton-Tirau through construction of the Waikato Expressway in order to support the use of Sh1-29 Auckland-Hamilton-Tauranga route over the SH2 and SH27 route.

The medium to long term efficiency improvements on this section of SH1 are therefore needed to retain the expected customer levels of service, journey time reliability, improve economic efficiency, and achieve the highest levels of safety.

SH1/SH29 Intersection

Whilst SH1/29 Intersection has been identified as a high risk intersection, is also the point where two national high volume routes meet. The intersection is currently an uncontrolled T intersection. Investigation for improvements is already underway but not completed. The draft Scheme Assessment Report includes two options – a roundabout and a partial grade-separated option with free flow grade separated ramps in both directions between the western SH1 Hamilton leg and the eastern SH29 Tauranga leg. Preliminary findings of the draft SAR considered the preferred option to be a partial grade separation due to a higher benefit cost ratio, compared to the negative BCR of the roundabout option. In the context of the SH1 Cambridge to Piarere PBC and the identified problems and benefits along this section of the state highway, the draft scheme recommendation should be reviewed in accordance with the programme outcomes and the ultimate efficiency upgrade.

9.3.3 Confirmation of Shortlisted Programme

The assessment of the shortlisted programme indicated that due to the nature of the problems, our response would be more complex than initially thought and the costs would be much higher than had been considered in the stakeholder workshop. As a result, programme alternatives which had been previously been discounted, need to be re-considered. Further work was then undertaken on the following programmes:

- Combined programme 2 & 3 – Combined safety and efficiency on-line Improvements to existing 2 lane carriageway with passing lanes
- Alternative programme 2 & 3 – Combined safety and efficiency on-line Improvements – On-line 4 laning

- Do Maximum – Do Maximum – Off-line State Highway – Expressway Standard

To assist with the testing and assessment of these 3 shortlisted programme, the concept of Investment Objectives was introduced.

9.3.4 Investment Objectives

Investment objectives are based on the problem statements and anticipated benefits as per the ILM Maps, however they provide a greater detail of clarity around what the programme will deliver. This was found to be more useful in helping identify the recommended programme. This work has been done retrospectively following the stakeholder workshops in this instance.

SMART targets were set for the Programme to provide criteria against which to measure the investment in the Programme, and these have been retrospectively included in the ILM Benefit Map (see Appendix B). The investment objectives are developed by comparing the baseline for the identified safety and economic efficiency performance of the corridor to the desired performance which will deliver the benefits identified for the project. The baseline and target outcomes were developed subsequent to the ILM problem and benefit mapping exercises and are based on the actual performance of the corridor relative to the agreed benefit and investment KPIs. The baseline and target outcomes are shown in Table 9-3 below.

Table 9-3: Target outcomes

Benefit	Baseline	Target	Relates to Problem			Relates to Benefit	
			1	2	3	1	2
Improved safety (70%)	15 DSIs in 5 year period 2010-2014 (14 car/vans, 1 HCV)	A 50% reduction of deaths and serious injuries across all modes over 10 years	✓	✓		✓	✓
	F&S crashes in 5 year period 2010-2014 (17 LOC, 4 overtaking, 8 crossing/turning)	A 50% reduction in crashes with death and/or serious injuries by type over a 10 year period	✓	✓		✓	✓
	Medium-High Collective Risk, 3.1 to 3.4 Star KiwiRAP (2015)	4 Star KiwiRAP road, by 2026	✓	✓		✓	✓
	22.3 crashes per 100M vehicle km	50% improvement in the crash rate per 100M vehicle km travelled by 10 years	✓	✓		✓	✓
Maintained/ improved economic efficiency along SH1-SH29 corridor (30%)	When expressway opens	Reduce standard deviation to 4min for cars and 2min for HCVs, by 2040	✓	✓	✓	✓	✓
	Daily traffic count with HCVs (when WEX opens)	A relative increase in HCVs and Cars on SH1-SH29 vs SH2-SH27 to 2040		✓	✓	✓	✓
	12.7 minutes from WEX tie in to Piarere in 2015, and 18 minutes in 2040.	CLOS standards (cars 100km/h = 10.2min; HCV 90km/h = 11.3min) to 2040	✓	✓	✓	✓	✓

As these outcomes are based on the workshop developed KPIs, the Investment Objectives for the programme combine the similar outcomes into four statements as follows:

- **Investment Objective 1:** We will reduce the deaths and serious injuries by 50%, between Cambridge and Piarere, over a 10 year period

  Investing in the programme is therefore expected to deliver approximately 7.5 deaths and serious injuries saved over a five year period, or in the case of the target 10 year period 15 DSIs will be saved.

- **Investment Objective 2:** We will improve the KiwiRAP Star rating for the Cambridge to Piarere section to a 4 Star road, by 2026

  Investing in the programme will raise the SH1 star rating between Cambridge and Piarere from between 3.1 and 3.4 stars to 4 stars. The outcome is the investment in an uplift of between 0.9 and 0.6 stars on SH1 within 10 years.

- **Investment Objective 3:** We will improve the journey time reliability of the Cambridge to Piarere

  Based on standard deviation of 4.1sec for light motor vehicles and 2.1sec for heavy motor vehicles and trailers[23] along the Waikato Expressway, the target set for this section of SH1 is similar. The investment in the recommended programme therefore invests in consistent and reliable journey times (and speeds) along the Waikato Expressway and through to the SH1/29 intersection. By 2040 the outcome of the investment is an erosion of 6 minutes on the journey between Cambridge and Piarere based on current peak hour journey times.

- **Investment Objective 4:** We will increase the throughput of freight and people along Cambridge to Piarere, in a relative increase to what is occurring along SH2 and SH27, by 2040.

  The investment in safe and efficient journeys along the Waikato Expressway and along SH1 between Cambridge and Piarere, where drivers will be exposed to fewer safety risks, delays, and conflict due to controlled access and intersection arrangements, will result in the Waikato Expressway/SH1 and SH29 being the route of choice on the Auckland to Tauranga journey. The outcome is an investment in fit for purpose journeys, with less efficiency related investment in the SH2 and SH27 routes, and greater traffic volumes of longer distance and freight traffic on SH1 and SH29.

Each of the three shortlisted programmes were tested against the target objectives in terms of the programme's ability to achieve the target Investment Objective.

Table 9-4: Assessment of Shortlisted Programmes against Investment Objectives

Investment Objectives		**Combined Prog 2 & 3** *Combined safety and efficiency on-line* *Improvements to existing 2 lane carriageway with passing lanes*	**Alternative Prog 2 & 3** *Combined safety and efficiency on-line* *On-line 4 laning*	**Prog 6** *Do Maximum* *Off-line Expressway Standard*
Baseline	Target	Ability to achieve investment objectives		
Medium-High Collective Risk, 3.1 to 3.4 Star KiwiRAP (2015)	4 Star KiwiRAP road[24], by 2026	Yes, but may be limited due to high traffic volumes.	Yes	Yes
22.3 crashes per 100M vehicle km	50% improvement in the crash rate per 100M vehicle km travelled by 10 years	Partially, but no capacity to accommodate increased traffic flows so will ultimately result in more crashes.	Yes, but not entirely as online conflict with intersections and accesses will increase with increasing flows.	Yes
When expressway opens	Reduce standard deviation to 4min for cars	No, with no capacity to accommodate increased traffic	Possible, but limited as online conflict with intersections and accesses will increase	Yes

[23] Based on standard deviation of 4.1sec for light motor vehicles and 2.1sec for heavy motor vehicles and trailers, Table 8-4 Traffic Flow Model Parameters, *2013/14 Annual Report: Analysis and Interpretation Report on Bluetooth Based Vehicle Monitoring Along the Waikato Expressway and the Wider Waikato Region.*

[24] KiwiRAP 4 Star definition for an undivided road is one which is Straight with good overtaking provision, good line marking and safe roadsides. Such a road will not achieve a 4-Star Rating if it has high traffic volumes.

	and 2min for HCVs, by 2040	journey times will deteriorate further.	with increasing flows and impact on journey time reliability.	
Daily traffic count with HCVs (when WEX opens)	A relative increase in HCVs and Cars on SH1-SH29 vs SH2-SH27 to 2040	Partially, opening of WEX may initially attract trips from other routes, but increasing delays over time in journey time will dissuade drivers.	Yes, but limited by opening of WEX which may initially attract trips from other routes, but increasing delays in the long term due to long term capacity constraints may dissuade drivers.	Yes
12.7 minutes from WEX tie in to Piarere in 2015, and 18 minutes in 2040.	CLOS standards (cars 100km/h = 10.2min; HCV 90km/h = 11.3min) to 2040	No, with no capacity to accommodate increased traffic journey times will continue to deteriorate.	Yes	Yes

9.4 Developing the Recommended programme

Based on the above assessment a number of key findings were highlighted in terms of identifying a **recommended programme** (Table 9-5).

- Based on the initial assessment undertaken during the Alternatives and Strategic Options Workshop, the stakeholders shortlisted Programmes 2 and 3 combined to deliver approximately 50% to 60% of the potential safety and efficiency benefits along this corridor. The scope of this shortlist programme assumed improvements to the current 2 lane carriageway with passing lanes. The potential interventions required to deliver the benefits are wide ranging, and hence (at that stage) the estimated costs ranged from around $5 million to $100 million.
- At this time this programme was favoured over the Do-Maximum (Programme 6 – new off-line state highway at expressway standard) which would deliver 90% to 100% of the benefits, but at a much higher cost of $200 million to $400 million.
- The additional analysis undertaken since the workshop confirmed that the shortlisted programme (combined Programme Options 2 & 3) is expected to deliver around 60% of the safety benefits. However the analysis also indicated that the cost range to deliver these safety benefits could be higher, in the range of $50 million to $100 million. This reflects the range of options and indicative interventions to provide edge line and centreline protection, turnaround facilities to maintain access and efficiency, and a range of possible interventions to improve safety at key intersections.
- In terms of efficiency the additional analysis indicated that journey reliability and travel times during peak times are likely to deteriorate in the future. On average current peak flows are approximately 70-80% of the lane capacity, and 80-90% of the capacity of the passing lane merges. The capacity therefore to cater for higher traffic volumes in the future without traffic flows breaking down in the peaks is limited, even with improvements to the current 2 lane carriageway and passing lanes. The scope for short term efficiency upgrades between Cambridge and Piarere are very limited, with a range of disbenefits that potentially outweigh the benefits gained by investing in the short term efficiency improvements.
- The analysis considered a transformational level of improvement to test the level of investment needed to cater the predicted traffic volumes reliably and efficiently. An on-line 4 laning alternative could cost $350-$450 million and would be expected to deliver around 80-90% of the efficiency benefits. There would still be a high level of conflict between local and inter-regional traffic however. It would also deliver up to 70-80% of the safety benefits.
- The off line 4-laning put forward for Programme 6 was reassessed at expressway standard at an estimated cost of $250 to $550 million. This would be expected to deliver 100% against the efficiency benefit, together with 90% of the safety benefits. The off-line alternative requires fewer major intersections compared to the on-line alignment.

- Stakeholder workshops did not specifically consider the SH1/29 intersection. The intersection however has been identified as a High risk intersection. The PBC has found that short term intersection safety initiatives will deliver safety benefits. In the longer term safety and efficiency need to both be considered with the longer term efficiency initiatives between Cambridge and Piarere. This should be carried out in the context of the importance of the Auckland to Tauranga journey and the Auckland to Tirau (and further to Wellington) journey, balancing the needs of the two journeys optimising efficiency and maximising safety.
- There is a wide range of expected costs, and this reflects the uncertainty in the standard to which the improvements will be delivered. This is particularly noticeable for the off-line alignment at expressway standard, where historical costs[25] for 4 lane bypasses around the country have ranged between $7.5 million/km to a much higher $22 million/km for a RONS standard expressway. This should be considered further at the IBC Stage.
- The assessment of the investment objectives against the shortlisted programmes showed that Programme 6 (off line expressway standard) performed best by meeting all of the objectives. The Alternative Programme 2 & 3 was the next best performing, meeting most of the objectives although with some limitations. The Combined Programme 2 & 3 does not perform well against the objectives as the capacity constraints on the corridor over time erode the programme's ability to meet the objectives.

Table 9-5: Summary of Additional Assessment of Shortlisted Programmes

	Combined Programme 2 & 3	Alternative Programme 2 & 3	Programme 6
Description	**Combined safety and efficiency on-line** Improvements to existing 2 lane carriageway with passing lanes	**Combined safety and efficiency on-line** On-line 4 laning	**Do Maximum** Off-line Expressway Standard
Benefits: Key for impact against the benefits: ■ High ■ Medium ■ Low			
Benefit 1 – Improving Safety **(70%)** *	60% to 70%	70% to 80%	90%
Benefit 2 – Improve/maintain economic efficiency along the SH1 (and SH29) corridor **(30%)** *	<10%	80% to 90%	100%
Percentage across all benefits (Weighted) *	**48%**	**80%**	**93%**
Indicative Cost Range	$50M to $100M	$350M to $450M	$250M to $550M
Timescales	3 to 10 years	10-15 years	8-12 years
Key Risks Key: ■ Low ■ Medium ■ High/Medium-High			
• Safety problem gets worse			
• Efficiency would deteriorate in the future	■	■ (Short/medium term)	■ (Short/medium term)
• Reputation – not addressing the problems	■ (Efficiency & Safety)	■ (Short term safety)	■ (Short term safety)
• Not achieving the wider benefits of the WEX	■		
• Not achieving shift of traffic from SH27 & SH2	■		
• Inconsistency with the WEX in place	■		
• Potential crash migration	■		
• Risks/acceptance of restricted local access	■	■ (Short term only)	■ (Short term only)
• Costs and funding availability	■	■	■
• Environmental and cultural impact risks		■	■
• Technical challenges of surrounding terrain		■	■

[25] Typical costs for median treatments, additional lanes, intersections, interchanges, new links, RONS standard bypasses, passing lanes, realignments, and safety improvements have been sourced from the NZ Transport Agency's Sin A Model database.

• Additional maintenance costs		■	■	■
Key Trade-offs		• Wider safety • Freight efficiency	• Other investments opportunities	• Other investments opportunities • Environment
Key Dependencies		• Timing of WEX • SH1/SH29 intersection improvements	• SH1/29 intersection form • Land & consenting	• SH1/29 intersection form • Land & consenting
Investment Objectives				
Baseline	Target	Ability to achieve Investment Objectives		
Medium-High Collective Risk, 3.1 to 3.4 Star KiwiRAP (2015)	4 Star KiwiRAP road[26], by 2026	Yes, but may be limited due to high traffic volumes.	Yes	Yes
22.3 crashes per 100M vehicle km	50% improvement in the crash rate per 100M vehicle km travelled by 10 years	Partially, but no capacity to accommodate increased traffic flows so will ultimately result in more crashes.	Yes, but not entirely as online conflict with intersections and accesses will increase with increasing flows.	Yes
When expressway opens	Reduce standard deviation to 4min for cars and 2min for HCVs, by 2040	No, with no capacity to accommodate increased traffic journey times will deteriorate further.	Possible, but limited as online conflict with intersections and accesses will increase with increasing flows and impact on journey time reliability.	Yes
Daily traffic count with HCVs (when WEX opens)	A relative increase in HCVs and Cars on SH1-SH29 vs SH2-SH27 to 2040	Partially, opening of WEX may initially attract trips from other routes, but increasing delays over time in journey time will dissuade drivers.	Yes, but limited by opening of WEX which may initially attract trips from other routes, but increasing delays in the long term due to long term capacity constraints may dissuade drivers.	Yes
12.7 minutes from WEX tie in to Piarere in 2015, and 18 minutes in 2040.	CLOS standards (cars 100km/h = 10.2min; HCV 90km/h = 11.3min) to 2040	No, with no capacity to accommodate increased traffic journey times will continue to deteriorate.	Yes	Yes

Assessment of the Shortlisted Programmes has enabled a recommended programme to be developed with justification provided below in Section 9.5.

[26] KiwiRAP 4 Star definition for an undivided road is one which is Straight with good overtaking provision, good line marking and safe roadsides. Such a road will not achieve a 4-Star Rating if it has high traffic volumes.

9.5 Recommended Programme

There is an **immediate action** to address **safety** along the corridor in the short term in line with the strategic options set out above. This may include a range of safety improvements from centreline treatments, edge protection, treatment of out of context curves and some intersection/access improvements.

- The short term need to address safety is due to the unacceptable crash record. Problem 1 identified poor driver behaviour coupled with a sub-standard road design for its current function as contributors to the high crash rate. This problem contributed 40% of the total problem along this section of SH1.
- It is acknowledged that addressing most or all of the problems along this section of the corridor (4-laning of the corridor for safety and efficiency) may take longer to implement, and that waiting for 10 to 15 years is unacceptable from a safety perspective. A safety solution is required sooner than this.
- Combined Programme 2 & 3 delivers 48% of all of the benefits, but importantly it is able to deliver 60 to 70% of the safety benefits within 3 to 10 years at approximately one third (or less) of the cost of the safety and efficiency upgrade. The cost range is expected to be between $50 million and $100 million.
- Following this assessment it was however still felt theat the timeframe for the delivery of the safety improvements (3 to 10 years) was still too long and an accelerated safety improvement programme is preferred. The original option workshop considered an On-line safety option (Programme 2 Safety Focus) which delivered 50% of all benefits and 60-70% of the safety benefits. At that time the cost range was $1 million to $50 million. Further consideration of the potential safety options (Appendix E) indicated that the cost range is more likely to be between $20 million and $50 million. This is the preferred short term on-line safety option.

Based on current traffic growth predictions there is likely to be a **medium to long term efficiency improvements** need to invest in additional capacity along SH1 between Cambridge and Piarere. Based on the comparative costs and benefits a **4 laning option, either on an on-line or an off-line alignment** is recommended.

- As traffic flows increase this section of the state highway will continue to experience pressures on capacity leading to degradation in journey time reliability and increased congestion.
- Both the Alternative Programme 2 & 3 (Combined safety and efficiency with on-line 4 laning) and Programme 6 (Do max off-line expressway) contribute significantly to the benefits identified for the project. Programme 6 however is expected to contribute more benefits, with 90% of safety and 100% of efficiency desired benefits achieved, with a weighted average of 93%.
- In addition to better contributing to the desired benefits, there are advantages to going off-line, including retaining the existing state highway alignment as a local road serving the local function of access and connectivity. The off-line alignment is then able to connect to the local network of sider roads via a rationalised series of interchanges, fewer than would be required with an on-line 4 laning.
- An additional benefit of an off-line alignment is that a fit for purpose alternate route is available along the existing SH1 alignment.
- A disbenefit of the off-line expressway is that the costs are expected to be higher, ranging between $250 million and $550 million, depending on the standard to which the expressway is delivered. There are risks around the certainty of these costs. In addition, there is a $50 million to $100 million short term investment required to upgrade the safety of the existing SH1 alignment between Cambridge and Piarere.
- There are also possible cultural and environmental disbenefits with an offline option.
- The SH1/29 intersection has been identified as a High risk intersection and short term intersection safety initiatives will deliver safety benefits. In the longer term safety and efficiency need to both be considered with the longer term efficiency initiatives between Cambridge and Piarere. As this activity is already underway as a current investigation, it is proposed as a separate activity in the recommended programme.

Each of the programme options achieves the investment objectives to varying degrees. The Combined Programme 2 & 3 is able to only partially achieve some of the outcomes sought (4 Star KiwiRAP, 50% reduction in crashes, and relative increase in traffic flows over SH 2 and 29), but it cannot achieve the target journey time or journey time reliability.

The Alternative Programme 2 & 3 performs better and is able to achieve all of the target outcomes, although not as successfully as Programme 6 which has the best safety and efficiency. Alternative Programme 2 & 3 has some long term limitations with combined on-line and off-line safety and efficiency improvements. The on-line sections will still be subject to some intersection and access conflict. Further work will need to be undertaken at IBC stage to consider the best option for providing medium to longer term efficiency improvements.

However, what is evident that either programme will not be delivered in the short term and therefore in order to respond to the current safety problem, a staged approach is recommended which comprises two core initiatives:

1. **immediate action** to address **safety** along the corridor in the short term.

2. Based on current traffic growth predictions there is likely to be a need to invest in **additional capacity** along SH1 between Cambridge and Piarere in the **medium to long term**. Based on the comparative costs and benefits a 4 laning option following an off-line alignment is recommended.

10 Recommended Programme

10.1 Programme Overview

This programme business case has been developed for the stretch of SH1 which extends from the end of the Waikato Expressway through to the intersection with SH29. The business case considers the best programme of activities to address key problems of safety and efficiency.

The recommended programme is a staged approach of implementing safety improvements in the short term followed by efficiency improvements in the medium to long term. The ultimate form of the efficiency improvements is yet to be determined and will be the focus of the IBC. The recommended programme also confirms the need for improvements to the SH1/29 Intersection. The recommended programme consists of three activities:

- Activity 1 – Short Term On-line Safety Improvements
- Activity 2 – SH1/29 Intersection
- Activity 3 – Longer Term Efficiency Improvements

The first part of the Programme related to safety (Activity 1 Online Safety) is expected to cost in the order of $20 million to $50 million.

- Some uncertainty exists in the suitability of the WEX interface, where the expressway transitions into the existing state highway to its east. The WEX project team has made allowance for this interface. Given the uncertainty of the suitability or effectiveness of the transition work that will shortly be implemented it is recommended that a period of monitoring be undertaken to assess its effectiveness. Should a crash problem eventuate then a new interface should be accelerated. The first set of out-of-context curves to the east of the WEX interface should be included.
- To provide centreline protection for as much of the corridor as possible between the Waikato Expressway tie-in and the SH1/SH29 intersection, including turnaround facilities where appropriate to maintain access to the state highway from local areas.
- To provide edge line protection where required. Given the high number of accesses and intersections this is likely to be targeted.
- To investigate and identify options to ensure safety at key intersections, including Hydro Road, Karapiro Road, Maungatautari Road, and SH1/29.
- Investigate options to improve the alignment of any out of context curves.

The second part of the Programme related to economic efficiency (Activity 3 Longer Term Efficiency) is expected to cost $250 million to $550 million.

- Investigate options to increase the capacity of the corridor with either on-line, off-line, or a mix between the two alignments for the state highway as an ultimate 4 lane expressway.
- The SH1/29 intersection (Activity 2) requires investigation in order that the ultimate form of the Cambridge to Piarere section of SH1 connects in an integrated manner with SH29, in respect to form, function and location. The intersection is required to be consistent with the programme outcomes, the findings of the SH1/29-ECMT Working Group, and the ultimate efficiency upgrade, including safety.

These investigations should be carried out as a series of Indicative Business Cases (IBCs) to ensure that appropriate optioneering, risk analysis, and costings are performed.

10.2 Programme Implementation Strategy and Timing

The recommended programme implementation is comprised of 3 discrete and staged activities. Each of the identified activities has a number of steps associated with the Business Case approach, and depending on the inputs required, the state of progress of previous or current investigations, the scale of the activity, and the outcome desired, the specific Business Case requirement needs to be tailored to suit.

- **Activity 1 – On-line Safety**

  Much of the SH1 Cambridge to Piarere PBC has focussed on the safety record of this section of SH1. Indicative treatments such as addressing the out-of-context curves, intersection improvements, edge treatments, and median treatments will provide value for money returns. It should be noted that there is the potential to achieve immediate safety benefits through low cost initiatives which would require relatively straight forward investigations and implementation.

  Due to the length of the route, the complexities along its length, and specific issues that need attention, an Indicative Business Case or Detailed Business Case, depending on the scale of the initiatives, is recommended to provide more certainty to the extent and scale of the interventions. It is expected however that the on-line safety improvements would take place within the road corridor without the need for additional land purchase.

  Depending on the outcome of the IBC/DBC and the scale of the short term safety improvements there exists the potential to move directly to Pre-Implementation and Implementation through the low cost initiatives.

  The safety of the journey has been acknowledged as a high priority and needs to be commenced as soon as possible, for delivery of the various initiatives over the next 0 to 3 years, depending on the scale and complexity of the interventions.

- **Activity 2 – SH1/29 Intersection**

  Safety analysis has determined that a transformational safety approach coordinated with the longer term efficiency upgrades of SH1 should be implemented. This confirms the identification of the intersection in the High-Risk Intersections Guide as being in the top 100 High Risk Intersections and ranked as number 81 on this list. Safety upgrades to this intersection should be planned for 6 to 10 years, with an IBC undertaken to determine the transformational form of the intersection.

  Activities 1 and 3 will progress in parallel, with Activity 3 Longer Term Efficiency determining the way forward for SH1/29, for example whether it needs to respond to a certain function, form, alignment, or location.

  The IBC should consider the short term and long term intersection treatments, developing detail to test the long term transformational form.

  There is potential that the DBC is carried out with Activity 3 Longer Term Efficiency DBC.

- **Activity 3 – Longer Term Efficiency**

  This activity is the upgrading of the corridor to deliver more efficient journeys and reliable journey times, delivered by a high capacity route without the conflict currently experienced due to the high number of accesses and intersections. Current traffic forecast indicate that this section is expected to be operating at capacity in the future, at which point traffic conditions will deteriorate significantly. Monitoring need to be in place to review these traffic levels and conditions.

  Some project feasibility work has been carried out previously (SH1 Corridor Plan 2010, and SH1 Cambridge to Piarere 4 Laning PFR 2011) where on-line, off-line and combined on/off alignments were considered.

  Significant work is still required to move this activity forward however, and an IBC should be commenced to determine the recommended form and alignment of this section of SH1.

  Design can be finalised at the appropriate time in a Detailed Business Case and the project taken forward for pre-implementation and implementation.

  Timing of the construction should be dependent on monitoring of traffic levels providing sufficient lead in time. Potentially this may be required in 8 to 12 years depending on traffic growth.

11 Recommended Programme – Assessment

This section assesses the performance of the recommended programme against three key criteria:

- Programme Outcomes
- Programme Risks
- Value for Money

11.1 Programme Outcomes

The stakeholder panel agreed two potential benefits along with the respective ratings to reflect the relative significance of each.

- **Benefit 1:** Improved safety **(70%)**
- **Benefit 2:** Improve/maintain economic efficiency along SH1 and SH29 corridor **(30%)**.

These have been further developed by the project team into Investment Objectives. Tables 11-1, 11-2 and 11-3 describe the ability of the three activities within the recommended programme to deliver on these. The three activities are staged over the short and long term, and their performance therefore varies over time.

Activity 1 – On-line Safety

- The ability of Activity 1 to achieve the safety target outcomes is good in the short term, but over time this will deteriorate. The targets of reducing crashes and DSIs by 50% within 10 years are achievable. The continued growth in traffic flows across the corridor however will compromise the safety performance of the corridor over time as exposure increases and conflict between local and through traffic becomes more of an issue. There is no capacity to accommodate increased traffic flows so will ultimately more crashes will result. Activity 1 therefore has a limited lifespan.
- The efficiency of the corridor will continue to deteriorate over time due to the capacity limitations of the corridor. The on-line safety improvements will not improve efficiency, leading to increasing journey times and less reliable trips. The opening of the WEX may initially attract trips from other routes, but increasing delays in the future, longer journey times and less trip reliability will dissuade drivers.

Table 11-1: Ability to Achieve Programme Outcomes for Activity 1

Benefit	Baseline	Target	Activity 1
			On-line Safety
Improved safety (70%)	15 DSIs in 5 year period 2010-2014 (14 car/vans, 1 HCV)	A 50% reduction of deaths and serious injuries across all modes over 10 years	Yes.
	F&S crashes in 5 year period 2010-2014 (17 LOC, 4 overtaking, 8 crossing/turning)	A 50% reduction in crashes with death and/or serious injuries by type over a 10 year period	Yes.
	Medium-High Collective Risk, 3.1 to 3.4 Star KiwiRAP (2015)	4 Star KiwiRAP road, by 2026	Yes, but may be limited due to high traffic volumes.
	22.3 crashes per 100M vehicle km	50% improvement in the crash rate per 100M vehicle km travelled by 10 years	Yes.
Overall performance against benefits for improved safety			50% for short term, but losing effectiveness in the longer term
Maintained/ improved economic efficiency along SH1-SH29 corridor (30%)	When expressway opens	Reduce standard deviation to 4min for cars and 2min for HCVs, by 2040	No, capacity constraints leading to delays result in journey time reliability becoming greater.
	Daily traffic count with HCVs (when WEX opens)	A relative increase in HCVs and Cars on SH1-SH29 vs SH2-SH27 to 2040	Partially, opening of WEX may initially attract trips, but increasing delays will dissuade drivers.
	12.7 minutes from WEX tie in to Piarere in 2015, and 18 minutes in 2040.	CLOS standards (cars 100km/h = 10.2min; HCV 90km/h = 11.3min) to 2040	No, with no capacity to accommodate increased traffic journey times will deteriorate further.
Overall performance against benefits for maintained or improved economic efficiency along SH1 and SH29 corridor			Less than 10%

Activity 2 – SH1/29 Intersection

- SH1/29 is able to meet the safety objectives as implementation is sought within the 6 to 10 year period.
- The design of the solution at the SH1/29 Intersection will need to take account of the planned longer term efficiency improvements for the corridor.

Table 11-2: Ability to Achieve Programme Outcomes for Activity 2

Benefit	Baseline	Target	Activity 2
			SH1/29 Intersection
Improved safety (70%)	15 DSIs in 5 year period 2010-2014 (14 car/vans, 1 HCV)	A 50% reduction of deaths and serious injuries across all modes over 10 years	Yes.
	F&S crashes in 5 year period 2010-2014 (17 LOC, 4 overtaking, 8 crossing/turning)	A 50% reduction in crashes with death and/or serious injuries by type over a 10 year period	Yes.
	Medium-High Collective Risk, 3.1 to 3.4 Star KiwiRAP (2015)	4 Star KiwiRAP road, by 2026	Yes..
	22.3 crashes per 100M vehicle km	50% improvement in the crash rate per 100M vehicle km travelled by 10 years	Yes.
Overall performance against benefits for improved safety			Once aligned with Activity 3 then 70 to 90% in the longer term.
Maintained/ improved economic efficiency along SH1-SH29 corridor (30%)	When expressway opens	Reduce standard deviation to 4min for cars and 2min for HCVs, by 2040	Yes, but ensure alignment with the longer term efficiency upgrades.
	Daily traffic count with HCVs (when WEX opens)	A relative increase in HCVs and Cars on SH1-SH29 vs SH2-SH27 to 2040	Yes, but ensure alignment with the longer term efficiency upgrades.
	12.7 minutes from WEX tie in to Piarere in 2015, and 18 minutes in 2040.	CLOS standards (cars 100km/h = 10.2min; HCV 90km/h = 11.3min) to 2040	Yes, but ensure alignment with the longer term efficiency upgrades.
Overall performance against benefits for maintained or improved economic efficiency along SH1 and SH29 corridor			80 to 100% for longer term.

Activity 3 - Longer Term Efficiency

- The longer term efficiency improvements could take the form of either on-line or off-line 4-laning, potentially including a divided carriageway. The long term safety and efficiency performance against the target outcomes is therefore expected to be good.

Table 11-3: Ability to Achieve Programme Outcomes for Activity 3

Benefit	Baseline	Target	Activity 3
			Longer Term Efficiency
Improved safety (70%)	15 DSIs in 5 year period 2010-2014 (14 car/vans, 1 HCV)	A 50% reduction of deaths and serious injuries across all modes over 10 years	Yes.
	F&S crashes in 5 year period 2010-2014 (17 LOC, 4 overtaking, 8 crossing/turning)	A 50% reduction in crashes with death and/or serious injuries by type over a 10 year period	Yes.
	Medium-High Collective Risk, 3.1 to 3.4 Star KiwiRAP (2015)	4 Star KiwiRAP road, by 2026	Yes.
	22.3 crashes per 100M vehicle km	50% improvement in the crash rate per 100M vehicle km travelled by 10 years	Yes.
Overall performance against benefits for improved safety			70 to 90% in longer term
Maintained/ improved economic efficiency along SH1-SH29 corridor (30%)	When expressway opens	Reduce standard deviation to 4min for cars and 2min for HCVs, by 2040	Yes.
	Daily traffic count with HCVs (when WEX opens)	A relative increase in HCVs and Cars on SH1-SH29 vs SH2-SH27 to 2040	Yes.
	12.7 minutes from WEX tie in to Piarere in 2015, and 18 minutes in 2040.	CLOS standards (cars 100km/h = 10.2min; HCV 90km/h = 11.3min) to 2040	Yes.
Overall performance against benefits for maintained or improved economic efficiency along SH1 and SH29 corridor			80 to 100% for longer term

Acknowledging it is recommended to implement a staged approach, the full programme outcomes will be delivered upon completion of the longer term improvements – 70 to 90% safety benefits and 80 to 100% efficiency benefits for a total estimated cost range of $300M-650M over a 15 year period. Until then, the short term actions will only deliver part of the outcomes but this will be at much reduced cost and over the next 3 years.

The problem statements, benefits sought and investment objectives used to develop this Programme Business Case have confirmed the following transport outcomes we expect to deliver through this investment:

- **A low crash rate with a reduced death and serious injury record appropriate for a national high volume route**
- **Improved journey time reliability** consistent with customer levels of service experienced on Waikato Expressway
- **Supporting economic growth of upper North Island** (preferred route choice for freight between Auckland and Tauranga supporting One Network Roading Classification)

11.2 Programme Risk

The Recommended Programme is expected to perform well in terms of achieving both safety and efficiency benefits. However there are some risks that were considered significant by the

stakeholders. These are primarily concerned with the off-line alignments and in particular with the cost and availability of funding, as well as environmental, cultural and technical challenges. In addition, given the timescales attached to this programme there is a significant risk that relates to not addressing the short term safety problems.

Technical	
• With hilly topography and the lake situated immediately adjacent to either side of the state highway this would be technically challenging	**Med-High**
Operational	
• There would be higher maintenance and operational funding demands on the national programme associated with having both the existing state highway and the new carriageway (in the case of the off-line alignment).	**Low**
Financial	
• Likely will require land take and property acquisition – therefore would be expensive	**Med-High**
• Given length of time to deliver project of this scale and complexity, it will be subject to a number of political and GPS cycles and therefore there is a risk over funding certainty	**Med**
• Given the scale of investment this may divert funding from other investment opportunities	**Med-High**
Stakeholder	
• Likely will require land take and property acquisition – therefore significant risk over acceptability by residents and land-owners, especially for the off-line alignment. For the on-line alignment it is likely that there will also be high degree of impact on residents and landowners due to the number of property frontages impacted and the arrangements that would need to be put into place to guarantee access.	**High**
• Risk of obtaining stakeholder support	**Med**
• Risk in obtaining community and stakeholder support	**Med**
Safety	
• Currently the safety issues causing the crashes at Hydro Road and Karapiro Road intersection are unclear – hence the type and scale of intervention is uncertain	**Low-Med**
• Safety problems and issues would still exist (and could get worse) in the short term	**High**
Cultural	
• Culturally sensitive area	**Med-High**
• Culturally sensitive in terms of land requirements (more so for the off-line alignment)	**Med-High to High**
Environmental	
• Environmentally sensitive area adjacent Lake Karapiro to the south and the Karapiro hills to the north (more so for the off-line alignment).	**Med-High to High**
Economic	
• Risk of moving the safety problem downstream and increasing the safety risk	**Low-Med**
Accessibility & Social Inclusion	
• Potential access issues in short/medium term related to possible safety measures	**Low**

11.3 Value for Money

Individual value for money assessments have not been carried out on these activities and it is recommended that this be done in the respective IBCs or DBCs as appropriate.

Based on historical data[27] indicative benefit cost values have been sourced for the various potential interventions and the relevant values are listed in Table 11-4. A benefit cost ratio (BCR) has not been carried out for the full recommended programme however, and for a Programme Business Case the guidance suggests that an indicative BCR only is required.

Due to the high cost of the expressway upgrading in comparison to the other potential interventions the BCR is likely to be weighted towards the costs and benefits of the full longer term efficiency upgrade. This is due to the fact that the longer term efficiency upgrade has the highest costs and also the largest proportion of economic benefits due to the travel time savings. It is reasonable therefore to assume that the BCR will be in the order of indicative BCR of 1.6 for the full efficiency upgrade.

By way of comparison, the other higher value interventions that might be considered in the programme include interchanges and additional lanes, which have BCR values of 1.9 and 8.9 to 10.7 respectively.

Table 11-4: Sin A Model Benefit Cost Ratios

Type of project	BCR
Additional lanes (block projects) 8.9	8.9
Additional lanes (large projects)	10.7
Interchanges	1.9
Intersections	3.5
Median treatments	2.7
New links and bypasses	2.3
New links and bypasses (RONS)	1.6
Passing lanes	2.6
Road realignment (block projects)	3.1
Road realignment (large projects)	2.1
Safety improvements	12.0

The programme BCR may therefore be greater than 1.6 and as such will fall in the BCR "Low" band of 1 to 3.

11.4 Sensitivity Analysis

An initial assessment of traffic growth was considered due to the concerns of the section approaching capacity of the passing lane merges. Analysis has shown that the lower bound of passing lane capacity had indeed been exceeded and that during peak times the passing lanes are subjected to unstable flow. As a result breakdowns in flow are occurring, and will become worse over time with continued traffic growth. Three traffic growth scenarios were considered with low and high traffic growth rates. Lower growth rates in traffic flows result in pressure on the midblock capacity is not as acute as with a high traffic growth rate. The range in timeframes is between 10 and 15 years before this capacity is reached.

[27] Typical BCRs have been sourced from the NZ Transport Agency's Sin A Model database.

At this stage no further sensitivity testing has been undertaken. This should be included as part of the detailed economic evaluation to support the development of the activities and the component IBCs and DBCs. The sensitivity tests should consider factors identified in the Uncertainty Log (Table 7-6) relating to the uncertainty over factors affecting demand, supply and cost, including:

- Change in government strategy – decrease or increase in investment
- Ruakura inland port in Hamilton
- Upgrade of rail connection between Hamilton and Tauranga
- Upper North Island Freight Story initiatives
- Completion of the Waikato Expressway
- Preferred scheme for the SH1/29 intersection upgrade
- National Resilience PBC

11.5 Investment Assessment

The programme has been assessed using the latest NZ Transport Agency Investment Assessment Framework. The three factors of Strategic Fit, Effectiveness and Benefit Cost Appraisal are assessed to determine how well proposed activities meet the government's investment strategy as defined in the Government Policy Statement on Land Transport.

Table 11-5: Project Investment Assessment Profile

Strategic Fit	
Assessment	Comments
High	The GPS 2015 continues the three key priorities identified in the GPS 2012 for economic growth & productivity, road safety, and value for money. SH1 is national (high volume) route and is integral to connecting the upper North Island, Waikato, Bay of Plenty with other parts of the central North Island and beyond. It is also critical to connecting a number of major urban populated areas including Hamilton, Tauranga, Auckland and more locally Cambridge. It provides access for freight to the ports in Auckland and Tauranga, as well as key industrial area across the region. An inland port is being planned in Hamilton, which will connect Auckland and Tauranga as a central distribution hub. SH1 between Auckland and Cambridge is being upgraded to expressway standard supporting its role as a Road of National Significance (RONS). The section of SH1 between Cambridge and Piarere connects directly to the Expressway (and RONS), and carrying as much traffic as the adjacent expressway sections it has an important role in realising the wider benefits of the Expressway upgrade. This route is therefore key to supporting economic growth and productivity across the region and in particular access to Hamilton's employment centres and surrounding industries. From a safety perspective this route is a high risk road. It has an identified safety issue and is a 3 star KiwiRAP and Medium-High collective risk state highway. In addition there is the risk that that the section of SH1 between Cambridge and Piarere connects directly to the Waikato Expressway (with the highest levels of safety) and will be out of context from a safety perspective. The evidence base of DSIs currently experienced along this route together with the low star rating and Medium-High collective risk indicate that this section of SH1 between Cambridge and Piarere should be a high priority for continuing delivery of the Safer Journeys vision of a safe road system increasingly free of death and serious injury. The ONRC has identified SH1 from Cambridge to Piarere as a national (high volume) route. Traffic conditions on this section of SH1 are expected to deteriorate significantly over time, resulting in delays with sub-optimal speeds and journey times for the movement of people and freight. The increased traffic volumes will also increase the risk of crashes occurring and people being killed and injured. Without intervention the National Programme Business Case for Safer Roads and Roadsides target of 3.5 star KiwiRAP standards will not be achieved. Land use changes are not expected to change significantly, with an expected degree of access to remain for roadside land use, including agricultural, horticultural and sports/recreational, as well

	as approximately 10 at-grade intersections along this section accommodating turning traffic volumes of between 50 and 800 vehicles per day. A **significant** gap therefore exists between the desired customer level of service and the actual or anticipated customer level of service.
Effectiveness	
Assessment	Comments
Medium	The recommended programme is expected to address short term safety and long term safety and efficiency. Outcomes focused – Rating is H - The benefits identified during the ILM workshop included improved safety and improve or maintain economic efficiency along SH1 (and SH29) corridor. The development of the programme options have focused on these outcomes, with assessment of the programmes identifying the degree to which these outcomes could be achieved. The preferred programmes confirm the safety and efficiency focus. Integrated – Rating is H - The Waikato Expressway is planned for completion in 2019/20, which completes the expressway standard route from Auckland through to Cambridge. The Expressway has the highest safety standard in NZ, and with a 4-lane dual carriageway it has high capacity with reliable and predictable journey times, and optimal travel speeds. The identified programmes are expected to improve the safety of the current SH1 route between Cambridge and Piarere in the short term, and upgrade the route to expressway standards thereafter. - The PBC takes into account the needs of the region with respect to land use adjacent to the corridor. There are not expected to be any significant changes to the current type or scale of the land use along the corridor, with the continued presence of predominantly agricultural, horticultural and sports/recreational based land use. Tourism will continue to perform a function with access to Lake Karapiro. Access through driveways and side roads will be retained in the short term and it is recommended that the IBC determines the management of these access points, through rationalization or consolidation of driveways, or realignment of side roads. - The PBC takes into account the needs of the region with respect to the multimodal use of the corridor. No Regional bus services are anticipated, although school buses do make use of the route for collecting or dropping off students. The IBCs that follow should investigate the facilities required for these services. No dedicated cycleway is planned for the route due to the lack of demand, although sealed shoulders should allow for cyclists. The Te Awa River Ride will cater for the tourism and recreational cycling function through the provision of a dedicated shared pathway parallel to the Waikato River. Correctly scoped – Rating is H - The National Programme Business Case for Safer Roads and Roadsides identifies a number of High risk corridors and intersections on the state highway network. In particular it identifies this section of SH1 between Cambridge and Piarere as a high risk corridor requiring action in the short term (0 to 3 years). This confirms the importance of developing an appropriate programme of interventions to improve this section. - The development of the National Resilience Programme Business Case is on-going. Early indications are that a preferred programme focus will be on keeping the state highway network open, or that an alternative route is always available, with a priority on national and high volume routes. Resilience and route security issues along SH1 between Hamilton and Waiouru are significant and support the case for future improvement. - The National Strategic Case for HPMV confirms the investment routes and this includes SH1. Affordable – Rating is M - A funding plan has not yet been established for either the safety improvements or the off-line expressway. The activities within the programme will still have to be progressed through the NLTP approvals process in order that funding can be secured. Timely – Rating is H - An indicative timing for the implementation of the activities indicates that the safety activities in the short term to turn around the poor safety record along this section of SH1. In the last year alone (2014) there were 3 fatal crashes. A dominant proportion of fatal and serious crashes involve drivers crossing the centreline/have a head-on crash, together with

	approximately a third of crossing/turning crashes. Driver behaviour coupled with an unforgiving road environment results in a high number of fatal and serious injuries. - Traffic growth along SH1 went through a period of little to no growth between 2004 and 2012, after which time traffic volumes have increased year on year. Current flows are impacting on the journey time and efficiency at the passing lane merges, where flows are starting to exceed the lower bounds of capacity and are now in the envelope of unstable flow. Traffic growths based on current rates indicate that the upper bound of the passing lane merge capacity will be exceeded within a year approximately, with the lower bounds of midblock lane capacity also being approached in around seven years. Planning for the off-line expressway activity should start as soon as possible. Provides confidence – Rating is H - The Recommended Programme is expected to perform well in terms of achieving both safety and efficiency benefits. There are however some risks with the 4 lane expressway activity relating to the cost and availability of funding, as well as environmental, cultural and technical challenges. This will be worked through the next stage of the IBC. - Staging our approach to delivery allows there to be a response to the safety problems now whilst providing an opportunity to monitor the changes in traffic volumes before implementing a high cost improvement activity. Overall – Rating is M - The lowest rating in the Effectiveness assessment is Medium for the Affordability component.
Benefit Cost Appraisal	
Assessment	Comments
Low	While an economic evaluation for this programme has not been completed at this stage, guidance has been taken from historical Transport Agency projects to establish the range in which the programme BCR may fall. Due to the high cost of the expressway upgrading in comparison to the other potential interventions the BCR is likely to be weighted towards the cost of the upgrade, with travel time savings being the main contributor to the economic benefits. It is reasonable therefore to assume that the BCR will be in the order of 1.6. Other high value interventions include interchanges and additional lanes, which have BCR values of 1.9 and 8.9-10.7 respectively. The programme BCR may therefore be greater than 1.6 and fall in the BCR Low band of 1-3.

The assessment profile has been determined for the programme as a whole (Table 11-5). It has been assessed as **HML**.

12 Programme Financial Case

12.1 Indicative cost

The preferred programme has three activities that would progress on separate timelines.

Activity 1 On-line Safety

- IBC/DBC cost range from $1 to $2 million (av. $1.5m)
- Pre-implementation and Implementation cost range from $47 to $95 million.

Activity 2 SH1/29 Intersection

- IBC cost range from $1.2 to $1.8 million (av. $1.5m)
- DBC cost range from $1.8 to $2.7 million.
- Pre-implementation and Implementation included in Activity 3.

Activity 3 Longer Term Efficiency

- IBC cost range from $4 to $9 million (av. $6.5m)
- DBC cost range from $6 to $13 million.
- Pre-implementation and Implementation cost range from $250 to $500 million (including SH1/29 efficiency upgrade).

The subsequent IBCs for each of the two recommended activities will more accurately determine the programme timing based on the traffic growth.

12.2 Funding arrangements

The programme will be funded through the National Land Transport Fund and subject to Transport Agency funding approval processes.

12.3 Affordability

Historical projects indicate that the BCR for the programme may fall in the range of 1-3, which is classified as Low. Whilst the economic assessment is yet to be carried out the indicative BCR is expected to be in the order of 1.6. Other high value interventions include interchanges and additional lanes, which have BCR values of 1.9 and 8.9-10.7 respectively.

PART C – DELIVERING & MONITORING THE PROGRAMME

13 Management Case

13.1 Management Case Overview

SH1 Cambridge to Piarere Programme Business Case		
Programme Sponsor	Kaye Clark	
Programme Manager	Anuradha Fitzwalter	
Programme Board	DMT, Hamilton	
Programme Steering Group	To be determined. A suggested steering group could consist of the following members: Representatives from NZ Police, Waikato Regional Council, Waipa District Council, Bay of Plenty Regional Council, iwi.	
Programme Monitoring	Operations Team	
Indicative Business Case lead	SH1 C2P On-line Safety	Peter Simcock
	SH1/29 Intersection	Peter Simcock
	SH1 C2P Longer Term Efficiency	Peter Simcock
Background	The SH1 Cambridge to Piarere programme business case identifies an optimal mix of alternatives and options without looking at the detailed solutions. The business case will be supported by the Transport Agency.	
General aims	The aim is to provide an understanding of the corridor's problems, opportunities and formulate the transport outcomes to be invested in.	
Initial risks	The corridor itself proposes a number of risks these include: - Land take and property acquisition - Medium-High collective safety risk, and would still exist (and potentially get worse) in the short term - Challenging environment and topography either side of the corridor, with higher risks for an off-line alignment - Culturally and environmentally sensitive	
Expected outcomes	The programme expects to: - Improved road safety through a reduction in deaths and serious injuries - Improve the KiwiRAP Start rating to 4 Stars - Improve the journey time reliability for all modes between Cambridge and Piarere as part of the longer Auckland-Tauranga and Auckland-Wellington journeys - Improve the throughput of people and freight on this corridor compared to the SH2-SH27 corridor.	
Initial estimate of costs and time	The Programme signals investment in excess of $50 to $100 million over the next 1 to 5 years for on-line short term safety	

	improvements. Also in the short term investigations are required into the short term and the longer term forms of the SH1/29 intersection to deal with safety and efficiency respectively. Investigation for the short term investigation of between $3 and $5 million is required over the next 4 years. In the longer term the SH1 Cambridge to Piarere efficiency upgrade will require an investment of $250 to $500 million over an 8 to 12 year period, which includes the longer term improvement to SH1/29 Intersection.
Outcome of the business case	The PBC will result in an agreed and certain investment signals for future investment decisions to be made.

13.2 Programme Governance and Reporting

What	When	Who/ How
DMT consider this PBC	15 June 2015	Anuradha Fitzwalter, DMT
VAC consider this PBC	25 June 2015	Anuradha Fitzwalter, VAC
NLTP Advisory Group consider this PBC	14 July 2015	Anuradha Fitzwalter, Advisory Group
NZ Transport Agency Board consider this PBC	14 August 2015	Anuradha Fitzwalter, Board
Monitoring of programme success	Quarterly	Network Operations team
Programme Steering Group	Quarterly	Transport Planning team
PBC is reviewed	The PBC should be reviewed following the On-line Safety Improvement implementation and prior to the Longer Term Efficiency DBC.	Transport Planning team

13.3 Programme Performance and Review

Reporting on performance for the programme includes referring to the investment Key Performance Indicators (KPIs).

Investment Benefit	Key Performance Indicator	Investment Outcome	Target
Deaths and serious injuries by mode	Number of DSI, by mode	We will reduce the deaths and serious injuries by 50%, between Cambridge and Piarere, over a 10 year period We will improve the KiwiRAP Star rating for the Cambridge to Piarere section to a 4 Star road, by 2026	A 50% reduction of DSIs across all modes over 10 years
	Crashes per km		4 Star KiwiRAP road by 2026
	Crashes by 100M vehicles km travelled		50% improvement in the crash rate per 100M vehicle km travelled by 10 years.
Crashes with deaths and/or serious injuries, by type	Number of crashes with DSIs by type		A 50% reduction in crashes with DSIs by type over a 10 year period
Reliability actual vehicles	Standard deviation of travel time	We will improve the journey time reliability of the Cambridge to Piarere section to ensure a standard of deviation that is 4min for light vehicles and 2min for HCVs, by 2040	Reduce standard deviation to 4min for cars and 2min for HCVs, by 2040
Travel time by mode	Minutes travel time		CLOS standards (cars 100km/h = 10.2min; HCV 90km/h = 11.3min) to 2040
Throughput people and freight, by mode	Number of people/freight moved (TBD)	We will increase the throughput of freight and people along Cambridge to Piarere, in a relative increase to what is occurring along SH2 and SH27, by 2040.	A relative increase in HCVs and Cars on SH1-SH29 vs SH2 and SH27 to 2040

PART D – PLANNING THE INDICATIVE BUSINESS CASES

14 Overview

14.1 Purpose

The primary purpose of the indicative business case (IBC) is to provide decision makers with an early indication of the preferred investment. It gives them an early opportunity to choose a recommended option to progress for further investment, influence the direction of the investment proposal and avoid wasting time and effort in developing investment proposals and options that should not proceed.

The next step in delivering the programme is to develop the identified options in to IBCs.

The recommended programme consisted of the following three activities on SH1 between Cambridge and Piarere:

1. Short term online safety improvements (0 to 3 years)
2. SH1/29 Intersection Improvements (6 to 10 years)
3. Longer term efficiency improvements (10 years+)

This Part D will act as the funding application, undertaken prior to the start of the IBC's phases, which will reconfirm the case for change, while scoping out each of the three IBCs.

14.2 Reconfirming the Case for change

The activities of the recommended programme have been identified to be progressed as soon as practicable, due to the pressures identified earlier in this PBC.

As a result of this immediate need, it is necessary to progress to the investment stage for all three of the activities.

As there is to be no delay between the completion of the PBC and the initiation of the three IBCs, it is confirmed that the case for change identified within the Strategic Case and the Programme Business Case is still correct and warrants progression through to the next phase.

14.3 TimeFrames

There is a need to address the safety concerns as early as possible, and in this regard the On-line Safety and SH1/29 Intersection IBC projects are required urgently for addressing (or at least investigating) the short term safety.

The IBC for the Longer Term Efficiency is also recommended to start as soon as possible due to the length of time required to carry out the investigations, which are then followed by a detailed design (DBC and Pre Implementation) process. Importantly, if an off-line alignment (or partially off-line alignment) is preferred then significant stakeholder engagement and consultation is required, in addition to a property procurement strategy and consenting process.

A recommended timeline is as follows:

- **On-line Safety IBC/DBC:** The IBC/DBC should start as soon as possible in the 2016 financial year to investigate and recommend the preferred on-line safety treatments. This should be completed within the financial year. The IBC/DBC will run in parallel with the Longer Term Efficiency IBC.
- **SH1/29 Intersection IBC:** The IBC needs to be timed to utilize the recommendations of the Longer Term Efficiency IBC to gain certainty on the function, form, alignment, or location of the intersection in light of the function, form and alignment of the SH1

Cambridge to Piarere efficiency improvement. This should be timed for year 6 of the current programme.

- **Longer Term Efficiency IBC:** Due to the scale of this investigation, the IBC will be carried out over multiple years. An early start in the 2016 financial year with a three year duration (max) should be allowed for to carry out the investigation, optioneering, and recommended option to be determined. The IBC will run in parallel with the On-line Safety IBC as the outcome of this work could impact on decisions related to the other two IBCs.

14.4 Financial Management Estimated Cost

Programme cost estimates have conservatively estimated the activities that would progress on separate timelines. Cost estimates for the phases within the activities include a 2% allowance of the IBC, 3% for the DBC, and the balance for the pre implementation and implementation. The programme includes the following three IBCs:

- On-line Safety: IBC/DBC cost estimate $1.5 million.
- SH1/29 Intersection IBC cost estimate $1.5 million.
- Longer Term Efficiency IBC upper cost estimate $6.5 million.

The assessment profile has been determined for the programme as a whole. It has been assessed as **HML.** See Table 11-5 for more detail on this assessment.

15 IBC Development

This section will detail how each of these activities will be further developed within their own IBC. While developed separately, each of the business cases will be developed to pay effect and will ensure the problem and benefits statements are achieved.

15.1 Short term On-line Safety Improvements Indicative Business Case/Detailed Business Case

15.1.1 Purpose

The purpose of this IBC/DBC to determine the scope of works required to achieve the short term safety outcomes on SH1 between Cambridge and Piarere.

15.1.2 Problem to be addressed

Within the PBC ILM session the following problem statements were identified in relation to safety:

- Problem 1: Poor driver behaviour coupled with a sub-standard road design for its current function leads to a high crash rate along the corridor (40%)
- Problem 2: Competing priorities of access and throughput along the corridor has contributed to the crash history (20%)

Analysis of the crash data within the PBC shows that 78% of all crashes are loss of control on bends and turning/crossing traffic. In the previous 5 years, 8 serious and fatal crashes have occurred. This has been a decline from the KiwiRAP analysis, where there were 18 fatal and serious crashes. This KiwiRAP analysis has implied a medium/high risk profile for the corridor.

The PBC has found that short term mid-block and intersection safety initiatives will deliver safety benefits through the implementation of the following:

- A widened centre line (without a wire rope barrier) between the Waikato Expressway interface and Piarere,
- Relatively low cost short term improvements at Hydro Road in the form of intelligent active warning signs, supplemented by additional signage and markings,
- Short term improvements at Karapiro Road in the form of improved visibility of side roads with islands.

15.1.3 Benefits and Investment Objectives

The PBC has developed investment objectives for the whole programme, and these objectives need to be tested against the shorter term focus of the online safety improvements and redefined with specific KPIs for the short term focus.

PBC Investment Objective	Applicable to On-line Safety IBC/DBC?	Target Applicable to On-line Safety IBC?
We will reduce the deaths and serious injuries by 50%, between Cambridge and Piarere, over a 10 year period	Yes	- A 50% reduction of DSIs across all modes over 10 years - 50% improvement in the crash rate per 100M vehicle km travelled by 10 years. - A 50% reduction in crashes with DSIs by type over a 10 year period
We will improve the KiwiRAP Star rating for the Cambridge to Piarere	No	N/A

section to a 4 Star road, by 2026		
We will improve the journey time reliability of the Cambridge to Piarere section to ensure a standard of deviation that is 4min for light vehicles and 2min for HCVs, by 2040	No	N/A
We will increase the throughput of freight and people along Cambridge to Piarere, in a relative increase to what is occurring along SH2 and SH27, by 2040	No	N/A

15.1.4 Geographic Boundary

The geographic boundary for the Short Term On-line Safety Improvements IBC/DBC will cover the entire 16km length of this section of State Highway 1 Cambridge to Piarere, from the Waikato Expressway tie in south of Cambridge, through to (and including) the SH1/29 intersection. Whilst a separate IBC will be progressed for the SH1/29 intersection, its timeframe for delivery is 6 to 10 years and therefore there may be a case for some short term improvements to the intersection.

15.1.5 Scope

Work will be undertaken within the IBC to better define the benefits, constraints and dependencies, to how they relate to the safety concerns along the corridor. This will involve greater analysis of the evidence base. This is detailed below:

- It is anticipated that we will analyse a range of options suitable in size and scale to address the safety concerns along the corridor. This size and scale will be reflected in the required effort to complete the IBC.
- The information used in the assessment and in developing the evidence base is safety related, and CAS records should be checked at the start of the IBC to use the most reliable data, and should be updated annually to monitor the safety performance once implemented.
- Engineering data collection is also required, and a full investigation of the corridor is required to gather precise road widths and cross section layouts, as well as understanding site constraints within the road corridor, such as services, drainage, access ways, etc.
- Property purchase or land acquisition are not expected, with safety improvements to be limited to the existing road corridor.
- At this stage for the safety improvements it is not expected to undertake public engagement in the form of Open Days however, there will be a need to engage with land owners particularly with any solution that may affect access and egress to properties. The range of stakeholders that will be involved within the option analysis and development of the IBC is detailed below.

15.1.6 Risks

On-line Safety IBC	
Risk	**Grading**
Technical • Applying on-line safety improvements within the corridor dimensions may be challenging at some mid-block locations and at some intersections.	**Med**
Operational • Loss of efficiency due to the safety initiatives may result.	**Low**

• Impacts on access to properties adjacent the highway due to the number of property frontages impacted and the arrangements that would need to be put into place to guarantee access (if wire rope barriers are used). • Medium to long term pressure on the corridor due to continued traffic growth means that the Waikato Expressway journey time savings will be eroded over time. • Failure to address capacity constraints will lead to all three of the problem statements recurring due to growth in traffic over time on the corridor and the completion of the Waikato Expressway.	**Med** **High** **High**
Financial • Potential for isolated areas of land take and property acquisition	**Med-High**
Stakeholder • Will require a degree of stakeholder engagement and community consultation. Risk over acceptability by residents and land-owners (especially if wire rope barriers are used). • Risk in obtaining community and stakeholder support	**High** **Low-Med**
Safety • Safety problems and issues would still exist (and could get worse) in the short term if the IBC is delayed.	**High**
Cultural • Culturally sensitive in terms of land requirements	**Low-Med**
Environmental • Environmentally sensitive area adjacent Lake Karapiro to the south and the Karapiro hills to the north.	**Med**
Economic • Risk of moving the safety problem downstream and increasing the safety risk	**Low-Med**
Accessibility & Social Inclusion • Potential access issues in short/medium term related to possible safety measures	**Low**

15.2 SH1/SH29 Intersection Indicative Business Case

15.2.1 Purpose

The purpose of this IBC to determine the scope of works required to achieve both the short term safety and the longer term efficiency outcomes at the SH1/29 intersection. It should be noted that an existing and current investigation into intersection improvements is underway, though on hold due to this PBC. It is anticipated that and IBC is developed with current work fed into the new business case.

15.2.2 Problem to be addressed

Within the PBC ILM session the following problem statements were identified in relation to safety:

- Problem 1: Poor driver behaviour coupled with a sub-standard road design for its current function leads to a high crash rate along the corridor (40%)
- Problem 2: Competing priorities of access and throughput along the corridor has contributed to the crash history (20%)

Within the NZ Transport Agency High-risk Intersections Guide[28], the top 100 High Risk Intersections were identified which and targeted the most high risk intersection in New

[28] Published 2013

Zealand. The State Highway 1 intersection with State Highway 29 was ranked as number 81 on this list.

This reflected the crash history between 2003 and 2012 of:

Type of Crashes	Number of crashes 2003-12
Minor Injury Crashes	11
Serious Injury Crashes	2
Fatal Crashes	1
Total Injury Crashes	14

The IBC is to consider safety and efficiency in the context of the longer term efficiency initiatives between Cambridge and Piarere. This should be carried out in the context of the importance of the Auckland to Tauranga journey and the Auckland to Tirau (and further to Wellington) journey, balancing the needs of the two journeys optimising efficiency and maximising safety.

15.2.3 Benefits and Investment Objectives

The investment objectives for this IBC should revisit the programme objectives and redefine them specifically for both the short term and longer term horizons required at the intersection.

PBC Investment Objective	Applicable to SH1/29 Intersection IBC?	Target Applicable to SH1/29 Intersection IBC?
We will reduce the deaths and serious injuries by 50%, between Cambridge and Piarere, over a 10 year period	Yes	- A 50% reduction of DSIs across all modes over 10 years - 50% improvement in the crash rate per 100M vehicle km travelled by 10 years. - A 50% reduction in crashes with DSIs by type over a 10 year period
We will improve the KiwiRAP Star rating for the Cambridge to Piarere section to a 4 Star road, by 2026	Yes	- 4 Star KiwiRAP road by 2026
We will improve the journey time reliability of the Cambridge to Piarere section to ensure a standard of deviation that is 4min for light vehicles and 2min for HCVs, by 2040	Yes	- Reduce standard deviation to 4min for cars and 2min for HCVs, by 2040 - CLOS standards (cars 100km/h = 10.2min; HCV 90km/h = 11.3min) to 2040
We will increase the throughput of freight and people along Cambridge to Piarere, in a relative increase to what is occurring along SH2 and SH27, by 2040	Yes	- A relative increase in HCVs and Cars on SH1-SH29 vs SH2 and SH27 to 2040

15.2.4 Geographic Boundary

The geographical scope of the IBC is the intersection and the approaches on all three legs.

15.2.5 Scope

Work will be undertaken within the IBC to better define the benefits, constraints and dependencies, to how they relate to the safety concerns along the corridor. This will involve greater analysis of the evidence base. This is detailed below:

- An existing Scheme Assessment Report has been prepared and is in draft form. The recommendations have not been accepted yet. it is recommended that the IBC revisit the technical assessment of this report in the light of the outcomes of the PBC, and especially undertake a review of the current SAR with respect to the investment objectives developed in the PBC.
- The information used in the assessment and in developing the evidence base is safety related, and CAS records should be checked at the start of the IBC to use the most reliable data, and should be updated annually to monitor the safety performance once implemented.
- Engineering data collection is also required, and a full investigation of the intersection is required to gather precise road widths and cross section layouts, as well as understanding site constraints within the road corridor, such as services, drainage, access ways, etc.
- Traffic flows are monitored consistently on nearby telemetry sites and a good profile of traffic volumes and type is available. This is especially important in understanding the actual change in flows (volume and mode) following the opening of the Cambridge section of the Waikato Expressway, as well as the opening of the Huntly and Hamilton Sections by 2019/20. Traffic modelling needs to be updated and calibrated against these new flows in order to benchmark future modelling forecasts.
- Stakeholder engagement is required, and is detailed below.
- Consultation is not expected on a broad scale, although directly affected parties will need to be consulted with.

15.2.6 Risks

SH1/29 Intersection IBC	
Risk	**Severity**
Technical	
• Need to understand longer term efficiency improvements to corridor to ensure good investment decision is made	**High**
• With the lake and gully situated immediately adjacent to the intersection this would be technically challenging.	**Med-High**
Operational	
• Loss of efficiency due to the safety initiatives may result.	**Low**
• Medium to long term pressure on the corridor due to continued traffic growth means that the Waikato Expressway journey time savings will be eroded over time.	**High**
• Failure to address capacity constraints will lead to all three of the problem statements recurring due to growth in traffic over time on the corridor and the completion of the Waikato Expressway.	**High**
Financial	
• Potential and take and property acquisition depending on form and location of intersection.	**Med-High**
• Given length of time to deliver the project (in combination with the Longer Term Efficiency improvements), it will be subject to a number of political and GPS cycles and therefore there is a risk over funding certainty	**Med**

Stakeholder • Potential land take and property acquisition, therefore risk over acceptability by adjacent land-owners (especially for the off-line alignment option). • Risk in obtaining community and stakeholder support	**High** **Med**
Safety • Safety problems and issues would still exist (and could get worse) in the short term	**High**
Cultural • Culturally sensitive area, although localised at the intersection.	**Low-Med**
Environmental • Environmentally sensitive area adjacent Lake Karapiro	**Med-High**

15.3 Long Term Efficiency Indicative Business Case

15.3.1 Purpose

The purpose of this IBC to determine the scope of works required to achieve the longer term efficiency outcomes on SH1 between Cambridge and Piarere.

15.3.2 Problem to be addressed

Within the PBC ILM session the following problem statements were identified in relation to safety:

- Problem 2: Competing priorities of access and throughput along the corridor has contributed to the crash history (20%)
- Problem 3: Future demand for the corridor is expected to exceed capacity potentially reducing the regions ability to support growth (40%)

The PBC has found that longer term efficiency is required through the provision of additional capacity along the route, as well as addressing the intersections and accesses along the route. There is a wide range of expected costs, and this reflects the uncertainty in the standard to which the improvements will be delivered. The IBC is required to test the right form of the highway which delivers the outcomes defined in this PBC. The form of the highway to be considered should include rural state highway alignment and standard and the lower end of the spectrum, through to Expressway standard highway at the other extreme.

15.3.3 Benefits and Investment Objectives

The investment objectives for this IBC should revisit the programme objectives and redefine them specifically for longer term efficiency objective.

PBC Investment Objective	Applicable to Longer Term Efficiency IBC?	Target Applicable to Longer Term Efficiency IBC?
We will reduce the deaths and serious injuries by 50%, between Cambridge and Piarere, over a 10 year period	Yes	- A 50% reduction of DSIs across all modes over 10 years - 50% improvement in the crash rate per 100M vehicle km travelled by 10 years. - A 50% reduction in crashes with DSIs by type over a 10 year period
We will improve the KiwiRAP Star rating	Yes	- 4 Star KiwiRAP road by

for the Cambridge to Piarere section to a 4 Star road, by 2026		2026
We will improve the journey time reliability of the Cambridge to Piarere section to ensure a standard of deviation that is 4min for light vehicles and 2min for HCVs, by 2040	Yes	- Reduce standard deviation to 4min for cars and 2min for HCVs, by 2040 - CLOS standards (cars 100km/h = 10.2min; HCV 90km/h = 11.3min) to 2040
We will increase the throughput of freight and people along Cambridge to Piarere, in a relative increase to what is occurring along SH2 and SH27, by 2040	Yes	- A relative increase in HCVs and Cars on SH1-SH29 vs SH2 and SH27 to 2040

15.3.4 Geographic Boundary

The geographical scope of the IBC is from the Waikato Expressway tie in south of Cambridge, through to (and including) the SH1/29 intersection. There will be some overlap with the SH1/29 Intersection IBC in the determination of the longer term form, location and layout of the intersection.

15.3.5 Scope

Work will be undertaken within the IBC to better define the benefits, constraints and dependencies, to how they relate to the safety concerns along the corridor. This will involve undertaken greater analysis of the evidence base. This is detailed below:

- Engineering data collection is also required, and a full investigation of the corridor is required to gather precise road widths and cross section layouts, as well as understanding site constraints within the road corridor, such as services, drainage, accessways, etc.
- Very limited information exists with which to test off-line alignment options. Previous PFRs have been carried out at desktop level in which off-line alignments were considered. It is feasible to use LiDAR information to test initial alignments and carry out long list assessments on this level of accuracy. Short list options require detailed consultation with stakeholders, engineering testing (preliminary geotechnical surveys), environmental assessments, and cultural assessments.
- As with the SH1/29 Intersection IBC traffic flows are to be monitored to understand the change in flows as a result of the opening of the southern sections of the Waikato Expressway. Traffic modelling needs to be updated and calibrated against these new flows in order to benchmark future modelling forecasts.
- It is expected that property purchase will be required, especially with the off-line alignment. Significant community consultation is required.
- Stakeholder engagement is required.
- Cultural, historical and environmental investigations and assessments should be undertaken to determine the scope and extent of the risks and impacts.

15.3.6 Risks

Longer Term Efficiency IBC	
Risk	**Severity**
Technical • With hilly topography and the lake situated immediately adjacent to either side of the state highway this would be technically challenging	**Med-High**

Operational	
• There would be higher maintenance and operational funding demands on the national programme associated with having both the existing state highway and the new carriageway (in the case of the off-line alignment).	**Low**
• Medium to long term pressure on the corridor due to continued traffic growth means that the Waikato Expressway journey time savings will be eroded over time.	**High**
• Failure to address capacity constraints will lead to all three of the problem statements recurring due to growth in traffic over time on the corridor and the completion of the Waikato Expressway.	**High**
Financial	
• Likely will require land take and property acquisition – therefore would be expensive	**Med-High**
• Given length of time to deliver project of this scale and complexity, it will be subject to a number of political and GPS cycles and therefore there is a risk over funding certainty	**Med**
• Given the scale of investment this may divert funding from other investment opportunities	**Med-High**
Stakeholder	
• Likely will require land take and property acquisition – therefore significant risk over acceptability by residents and land-owners, especially for the off-line alignment. For the on-line alignment it is likely that there will also be high degree of impact on residents and landowners due to the number of property frontages impacted and the arrangements that would need to be put into place to guarantee access.	**High**
• Risk of obtaining stakeholder support	**Med**
• Risk in obtaining community and stakeholder support	**Med**
Safety	
• Currently the safety issues causing the crashes at Hydro Road and Karapiro Road intersection are unclear – hence the type and scale of intervention is uncertain	**Low-Med**
• Safety problems and issues would still exist (and could get worse) in the short term	**High**
Cultural	
• Culturally sensitive in terms of land requirements (more so for the off-line alignment)	**Med-High to High**
Environmental	
• Environmentally sensitive area adjacent Lake Karapiro to the south and the Karapiro hills to the north (more so for the off-line alignment).	**Med-High to High**
Economic	
• Risk of moving the safety problem downstream and increasing the safety risk	**Low-Med**
Accessibility & Social Inclusion	
• Potential access issues in short/medium term related to possible safety measures	**Low**

15.4 Programme Organisation

SH1 Cambridge to Piarere – Resourcing for Indicative Business Cases	
Programme Sponsor	Kaye Clark
Programme Manager	Anuradha Fitzwalter
Programme Board	DMT, Hamilton

Programme Steering Group	To be determined. A suggested steering group could consist of the following members: Representatives from NZ Police, Waikato Regional Council, Waipa District Council, Bay of Plenty Regional Council, iwi.	
Programme Monitoring	Operations Team	
Indicative Business Case lead	SH1 C2P On-line Safety	Peter Simcock
	SH1/29 Intersection	Peter Simcock
	SH1 C2P Longer Term Efficiency	Peter Simcock
Initial estimate of costs and time	The Programme signals investment in excess of $50 to $100 million over the next 1 to 5 years for on-line short term safety improvements. Also in the short term investigations are required into the short term and the longer term forms of the SH1/29 intersection to deal with safety and efficiency respectively. Investigation for the short term investigation of between $3 and $5 million is required over the next 4 years. In the longer term the SH1 Cambridge to Piarere efficiency upgrade will require an investment of $250 to $500 million over an 8 to 12 year period, which includes the longer term improvement to SH1/29 Intersection.	

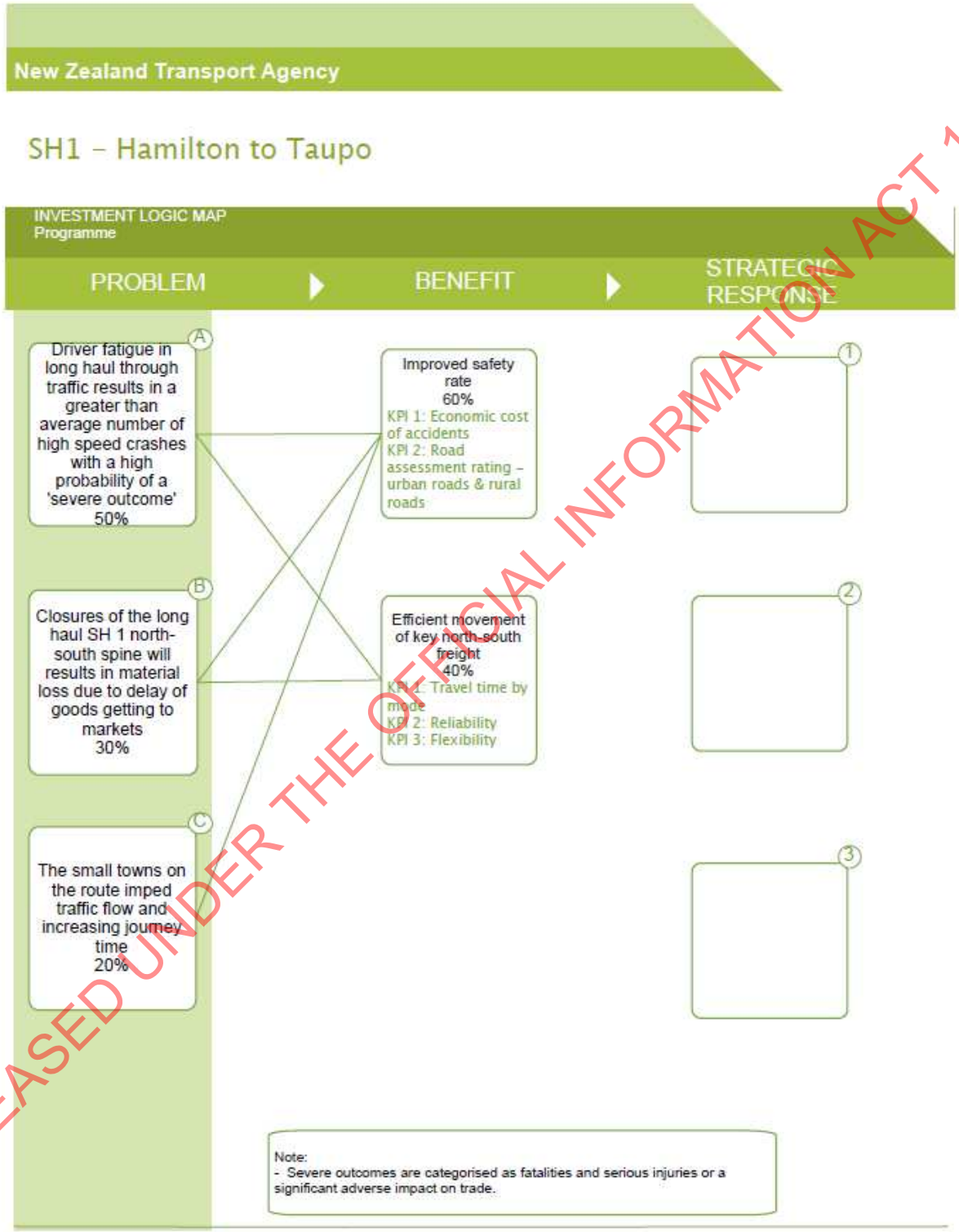
15.5 Key Stakeholders

The key stakeholders who have an interest in the expected outcomes and can influence the investment proposal are outlined for all IBCs below.

- NZ Transport Agency
    - Highways Network Operations
    - Transport Planning
    - Road Safety
    - Network Operations
    - Project Services
    - Property Team
    - Environment and Urban Design
    - Pavements
    - Regional Performance Team
    - Planning & Investment
- Waikato Regional Council
- Road Transport Association
- Freight Logistics Action Group
- Waipa District Council
- South Waikato District Council
- NZ Police
- iwi:
    - Ngati Raukawa
    - Puawai

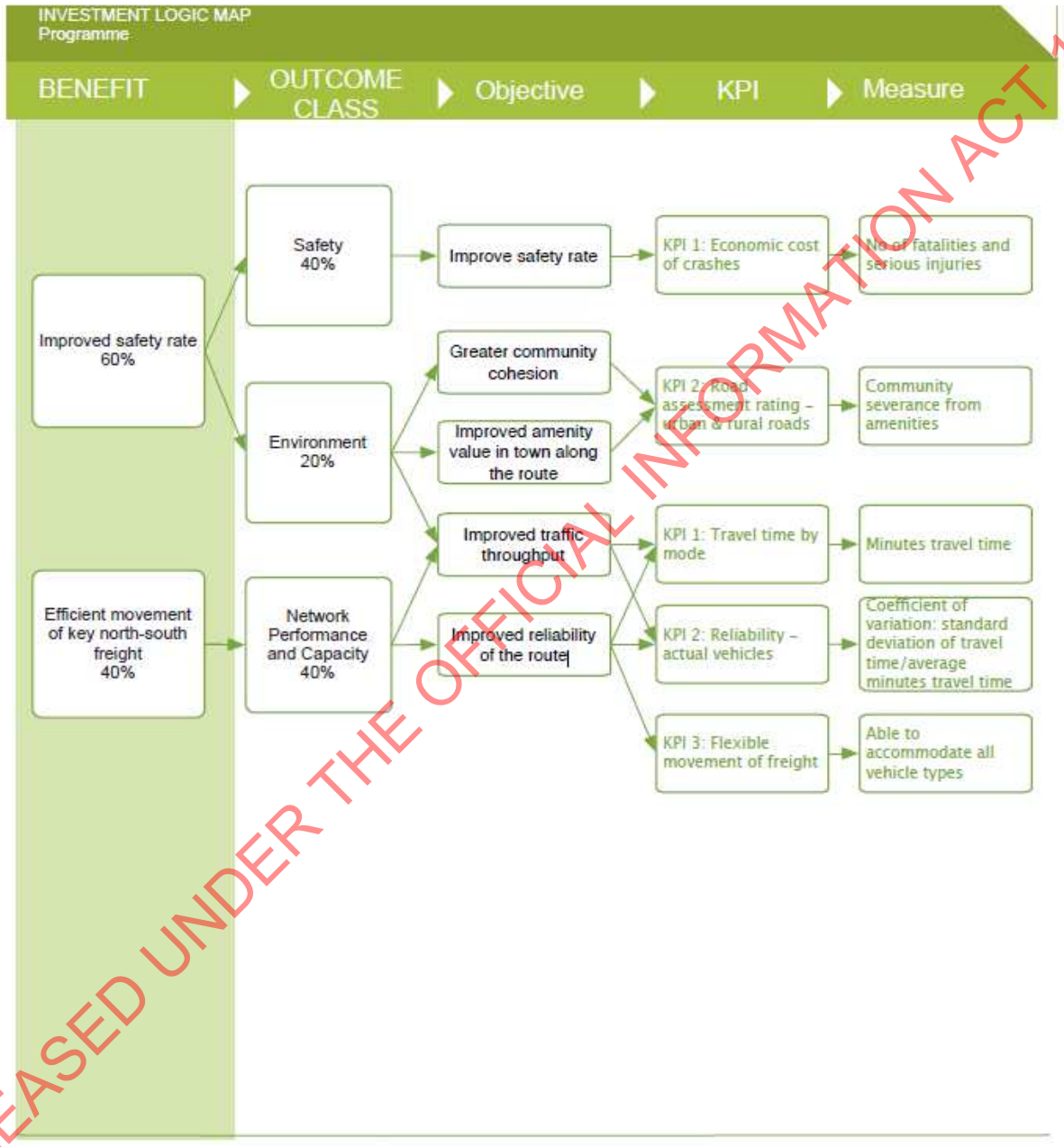
- Ngati Koroki Kahukura
- Ngati Haua

Appendix A: ILM for Hamilton to Waiouru Improvements (Hamilton to Taupo Section)



New Zealand Transport Agency

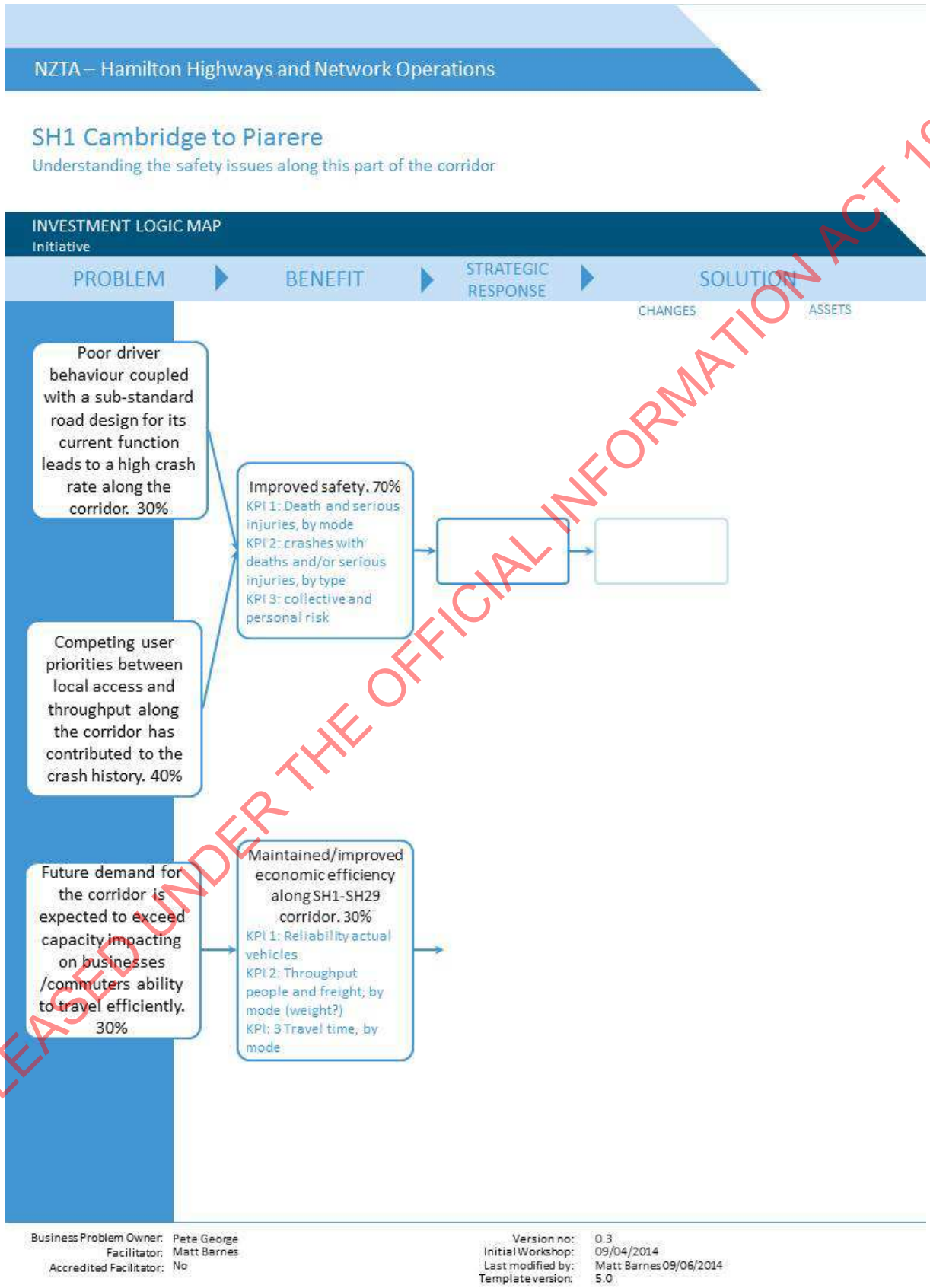
SH 1 – Hamilton to Taupo



InvestorVersion no: Anuradha Fitzwalter
Facilitator Stephen Davies Howard
Accredited Facilitator: Yes

Version no: 1.0
Initial Workshop: 11/12/1013
Last modified by: Stephen Davies Howard 02/01/2014
Template version: 5.0

Appendix B: ILM for Cambridge to Piarere Improvements

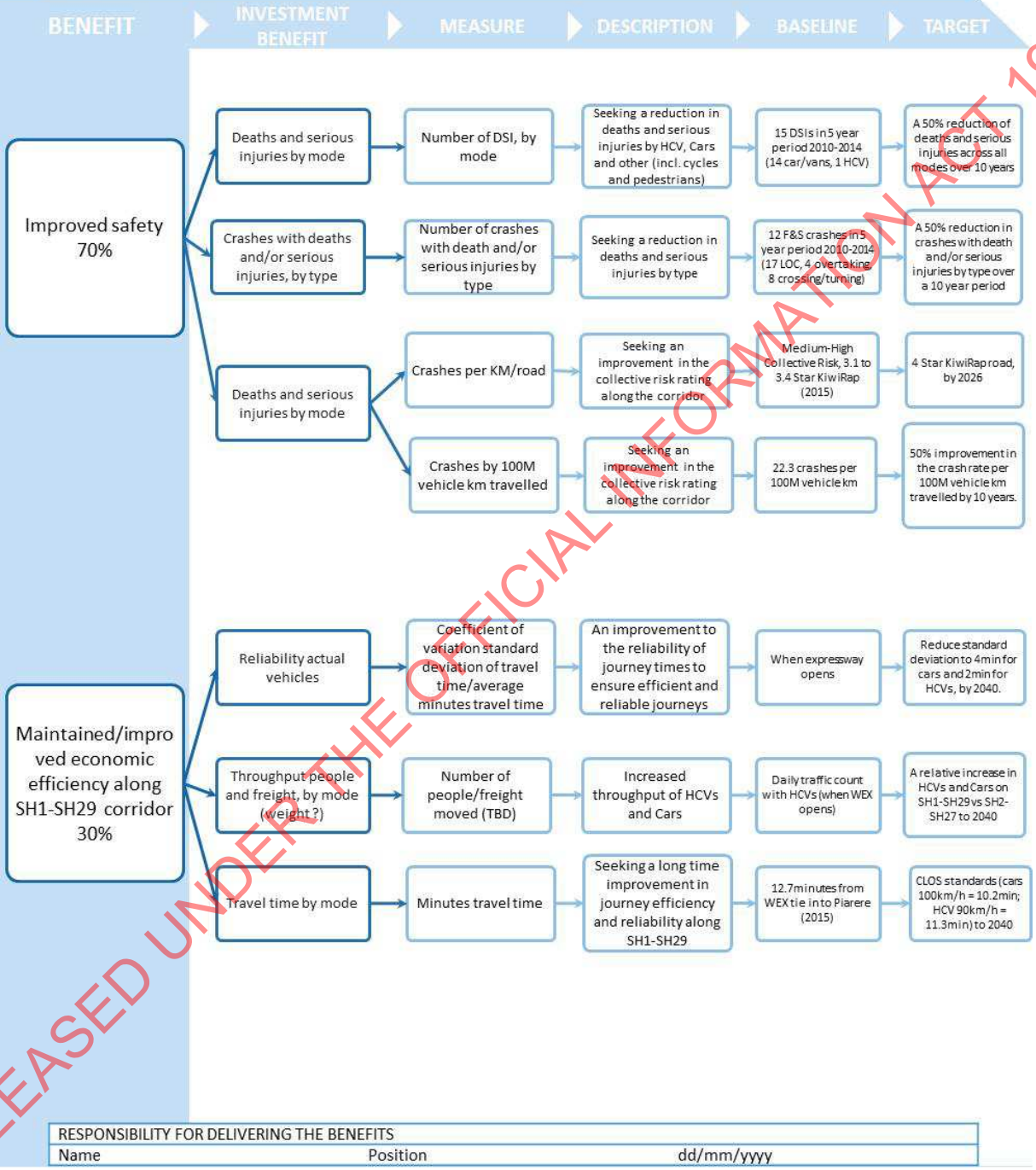


NZTA – Hamilton Highways and Network Operations

SH1 Cambridge to Piarere

Understanding the safety issues along this part of the corridor

BENEFIT MAP



RESPONSIBILITY FOR DELIVERING THE BENEFITS		
Name	Position	dd/mm/yyyy

Business Problem Owner: Pete George
Facilitator: Matt Barnes
Accredited Facilitator: No

Version no: 0.2
Initial Workshop: 03/06/2014
Last modified by: Shaun Lion-Cachet 09/06/2015
Template version:

Appendix C: Alternatives Programme and Strategic Options Workshop – Initial Assessment Framework

SH1 Piarere to Cambridge Improvements

Problem Owner: Anuradha Fitzwalter
Facilitator: Matt Barnes
Initial Workshop: 10/09/2014
Version No.: 0.1
Last Modified by: Pete George
17 Sep 2014

Programme options

			Programme 1	Programme 2	Programme 3	Programme 4	Programme 5	Programme 6
			Do Minimum	**Safety Focus (On-line)**	**Efficiency Focus (On-line)**	**Efficiency Focus (Offline Local Roads)**	**Local Access/Use Focus (Safer turning/Reducing conflicts)**	**Do Maximum (OfflineState Highway - Expressway Standard)**
Outcome: Network Performance & Capability								
	Relative Importance of objective		What is achievable if implemented	What is achievable if implemented	What is achievable if implemented	What is achievable if implemented	What is achievable if implemented	What is achievable if implemented
Benefit 1	Improving safety	70%	5%	70%	10%	30%	25%	90%
Benefit 2	Improve/maintain economic efficiency along SH1 (and SH29) corridor	30%	5%	5%	50%	50%	5%	100%
	Overall weighted		***5%***	***51%***	***22%***	***36%***	***19%***	***93%***
Cost								
Investment cost (Range)			$1 M	$1M - 15M+	$1M - 15M+	$5M - 15M+	$1M - 5M	$300M to $500M
Operational costs if significant (Range)								
Time								
(Range)			per annum	3-6 years	3-10 years	5-15 years	3-6 years	10-15 years
Risks								
Technical			-	-	-	With hilly topography and the lake situated immediately ajacent to either side of the state highway this would be techically challenging		Similar to Programme 4
Operational			More freight traffic continues using other routes (e.g. SH27) as well as SH1, resulting in increasing maintenance costs	Higher maintenance costs	With people contiuing to use other routes more Police resources required to monitor and enforce	Left with existing SH with sub-standard alignment, accesses, etc Higher maintenance costs assoacietd with having both the existing state highway and the new carriageway	-	Similar to Programme 4
Financial			-	Affordability to action safety improvements in short term	-	Likely will require land take and property acquisition - therefore would be expensive	Likely will require some land take and property acquisition - therefore would be expensive	Similar to Programme 4 Given length of time to deliver project of this scale and complexity, it will be subject to a number of political and GPS cycles and therefore there is a risk over funding certainty Given the scale of investment this would likely divert funding from other investment opportunities
Stakeholder/Public			Driver expectation in terms of continuity between the new expressway with a high level of service and the existing SH1 Organisational reputation relating to expectations for SH1 as a national route Not delivering investor/land-use confidence	May be seen as migrating the problem downstream of this section May impact / be incosistent with future investment May not meet the expectations of the custome on terms of achieving key outcomes (safety and efficiency)	With people continuing to use other routes more Police resources required to monitor and enforce Organisational reputation relating to expectations for SH1 as a national route, and not meetingthe safety objectives	Likely will require land take and property acquisition - therefore significant risk over acceptability by residents and land-owners Likely to be culturally sensitive in terms of land requirements Risk of obtaining stakeholder support Risk of increaseing public security for local residents, land-owners and amenities Reducing the amenity value of the area	Likely will require some land take and property acquisition - therefore likely to be subject to public acceptance issues Possible organisational reputation risk relating to expectations of users over meeting journey outcomes for efficiency, safety and access	Similar to Programme 4 Risk in obtaining community and stakeholder support Given length of time to deliver project of this scale and complexity, it will be subject to a number of political and GPS cycles and therefore there is a risk over funding certainty
Environmental			-	-		Environmentally and culturally sensitive area	-	Similar to Programme 4
Safety			Continue increasing the risk of safety and the crash rate Not meeting the Safer Journeys objectives at mid block and intersections	Migration of the problem Might not achieve all the safety benefits - i.e. not forgiving enough for the form and function of SH1 There may still be speed related safety issues Compromising the delivery of wider safety benefits of the Waikato Expressway	The safety objectives will not be met Potentially introduces new safety issues Potentially could increase running speeds along this section There would still be conflicts between local and inter-regional traffic	Might not deliver safety benefits sought - would still need to look at safety improvements required along the existing state highway May increase safety risk for cycling along this corridor	Might not deliver all the safety benefits sought (only focusses on turning conflicts and access issues) Improving access for local amenities and properties may attract more turning traffic thereby potentially eroding some of the potential gained benefits (safety and afficiency)	Similar to Programme 4, and same as Do-Minimum in the short/medium term Safety problems and issues would still exist (and could get worse) in the short term and possibly medium term
Economic			Ability to cater future volumes of traffic Deterioration in levels of service over time in terms of journey time reliability Not achieving shift of traffic expected with expressway, including freight traffic from the SH27 corridor Does not support achieving potential land use growth Not realising the full benefit potential of the completed expressway Not delivering investor/land-use confidence	There are potential trade off impacts in terms of journey time efficiency (people and freight) May not achieve journey time/relability savings Possible would not support achieving the desired shift of trafic to the Expressway (say from SH27) Depending on the type of safety measures, the safety options detours may be imposed on local traffic with travel time and distance dis-benefits May not support achieving future potential land-use changes Not delivering investor/land-use confidence Not achieving commercial objectives	The shift in traffic to the Expressway corridor may be marginal, and not achieve the full potential	Potential loss of productive land	May compromise the achievement of efficiency benefits with combination of increasing levels of throughput traffic and possible speed management measures Improving access for local amenities and properties may attract more turning traffic thereby potentially eroding some of the potential gained benefits (safety and afficiency) Not achieving shift of traffic expected with expressway, including freight traffic from the SH27 corridor Possibly compromise achieving the full benefits of the Waikato Expressway	Similar to Programme 4, and same as Do-Minimum in the short/medium term Efficiency and reliability problems would likely manifest in the medium term Risk of moving the safety problem downstream and incrasing the safety risk
Accessibility & Social Inclusion			Issues relating to local access still exist	Some design options may impose a detour/restriction for traffic accessing local areas and amenities	Accessibility to local areas/amentities would be reduced/restricted at some locations May not be able to access certain parts of the Lake Karapiro and the associated recreational use with restricted turns and higher traffic volumes	-	May not fully address issues relating to access	Similar to Programme 4, and same as Do-Minimum in the short/medium term
Other			-	-	-	-	-	-
Dis-benefits								
Dis-benefit 1			difficult to maintain levelof service over time	not meeting commercial objectives	Safety outcomes might not be achieved	higher maintenance costs	not achieving shift og SH2 and SH27 traffic	opportunity cost of other investments
Dis-benefit 2			would not achieve benefits of overall strategic outcomes	might not achieve safety outcomes expected for a national route	possible impact on local users if not designed appropriately	not address safety benefits (still need safety measures on SH1	possibly lose benefits gained from the Waikato expressway	environmental impacts
Dis-benefit 3			not achieve strategic objectives for the corridor	might compromise the wider safety benefits of the Waikato expressway			not met Safer Journeys outcomes	timeframes and not addresing short term issues, and still need to maintain the current corridor
Indicative Programme Profile:								
Ranking								
			5	**1**	**1**	**3**	**4**	**2**

Appendix D – Initial Assessment of Programme Options

This section sets out the initial assessment of the programme options in terms of the expected performance of each against four key criteria:

- Achieving the investment benefits
- Indicative cost ranges and value for money
- Timeframes
- Key project risks and implementability.

The initial assessment and short-listing was undertaken in the Alternatives and Strategic Options Workshop. The output of the workshop is presented in Appendix E. The keys findings of this initial assessment of the programme options is set out below.

Programme 1 – Do-Minimum Alternative

The Do-Minimum (Programme 1) does very little in terms of achieving the potential benefits. The stakeholders were concerned safety would get worse and that journey time efficiency would also deteriorate considerably with future traffic growth predictions.

Performance against achieving investment benefits

Benefit 1: Improving safety (70%)	Overall a **reduction of less than 5% in fatal and serious injury crashes** was given for the Do minimum. This programme does very little to address the problems relating to loss of control/head-on crashes and crashes involving traffic crossing/turning at intersections and accesses.
Benefit 2: Improve / maintain economic efficiency along SH1 (and SH29) corridor (30%)	Overall it was agreed that this programme **would not deliver much in terms of improving efficiency (less than %5)**. It was also considered that under this programme the efficiency of the corridor would deteriorate further with future traffic growth.

Cost and Time Ranges

The rough order cost range for the Do-Minimum is $1 million per annum on an on-going basis.

Key programme risks and issues

The key risks associated with the Do-Minimum and its implementability were discussed during the alternatives and strategic options workshop with the stakeholder panel. These are set out and assessed below.

The Do-Minimum is not expected to deliver much in the way of safety or efficiency on the SH1 corridor. As such the key risks relating to safety, future efficiency and reputation of not addressing the problems on the state highway are considered significant.

It would be seen to be undermining the strategy behind the completion of the Waikato Expressway and encouraging a shift of strategic traffic, and particularly trucks from alternative routes such as SH27 and SH2.

Operational	
More freight traffic continues using other routes (e.g. SH27) as well as SH1, resulting in increasing maintenance cost	Med
Stakeholder	
Driver expectation in terms of continuity between the new expressway with a high level of service and the existing SH1	**Med-High**
Organisational reputation relating to expectations for SH1 as a national route	**Med-High**
Not delivering investor/land-use confidence	**Med-High**
Safety	
Continue increasing the risk of safety and the crash rate	**High**
Not meeting the Safer Journeys objectives at mid-block and intersections	**High**
Economic	
Ability to cater future volumes of traffic	**Med-High**
Deterioration in levels of service over time in terms of journey time reliability	Med
Not achieving shift of traffic expected with expressway, including freight traffic from the SH27 corridor	Med
Does not support achieving potential land use growth	Med
Not realising the full benefit potential of the completed expressway	Med
Not delivering investor/land-use confidence	Med

Programme 2 – Safety Focus (On-line)

Considering a range safety improvements from centreline treatments, edge protection, treatment of out of context curves and some intersection/access improvements this programme option would perform relatively well in terms of safety (up to 60% or 70%). However with the current standard of carriageway together with the high number of accesses and intersections, there is a limit to what can be achieved and the safety problems will not be fully addressed.

As with the Do-Minimum this programme option does very little in terms of journey time efficiency, and could get worse with future traffic growth.

Performance against achieving investment benefits

Benefit 1: Improving safety (70%)	Overall a **reduction of 60% to 70% in fatal and serious injury crashes** could be expected under Programme 2.
Benefit 2: Improve / maintain economic efficiency along SH1 (and SH29) corridor (30%)	Being focussed on safety, this programme would not deliver much in the way of efficiency benefits, i.e. **less than %10**. Similarly the efficiency of the corridor could deteriorate significantly with future traffic growth.

Cost and Time Ranges

The rough order cost range for Programme 2 is $1 million to $50 million. The wide range here reflects the range of interventions that were being considered at this stage, and would be subject to further investigation and shortlisting in subsequent phases.

This programme could be implemented within a 3 to 6 year timeframe.

Key programme risks and issues

The key risks associated with Programme 2 and its implementability are set out below.

Programme 2 will deliver some safety improvements mainly around loss of control on bends and straights, along with some of the intersection/access issues. However being an on-line alternative it will not be able to address all access and intersections issues. It does not deal with efficiency either. Therefore key risks relating to reputation and not meeting the expectations of the customer in terms of achieving efficiency and access outcomes, compromising the wider benefits of the Waikato Expressway, route inconsistency and potential crash migration are considered significant.

Operational	
• Higher maintenance costs	Med
Financial	
• Affordability to action safety improvements in short term	Low
Stakeholder	
• May be seen as migrating the problem downstream of this section	Med
• May impact / be inconsistent with future investment	Med
• May not meet the expectations of the customer in terms of achieving key outcomes (safety and efficiency)	**Med-High**
Safety	
• Migration of the problem	Med
• Might not achieve all the safety benefits – i.e. not forgiving enough for the form and function of SH1	Med
• There may still be speed related safety issues	Med
• Compromising the delivery of wider safety benefits of the Waikato Expressway	Med
Economic	
• There are potential trade off impacts in terms of journey time efficiency (people and freight)	Med
• May not achieve journey time/reliability savings	**Med-High**
• Possibly would not support achieving the desired shift of traffic to the Expressway (say from SH27)	Med
• Depending on the type of safety options considered detours may be imposed on local traffic with travel time and distance dis-benefits	**Med-High**
• May not support achieving future potential land-use changes	Low
• Not delivering investor/land-use confidence	Med
• Not achieving commercial objectives	Low
Accessibility & Social Inclusion	
• Some design options may impose a detour/restriction for traffic accessing local areas and amenities	Low

Programme 3 – Efficiency Focus (On-line)

In the workshop the stakeholders considered this programme options as being about improvements to the existing 2 lane arrangements with passing lanes. In terms of maintaining journey efficiency while catering future traffic levels the stakeholders felt this could achieve around 50% of the potential

benefits. In terms of safety this programme was seen to do very little to reduce crashes and ultimately deaths and serious injuries.

Performance against achieving investment benefits

Benefit 1: Improving safety (70%)	With scope under this programme to improve intersections and passing lanes it was felt that a **reduction of up to 10% in fatal and serious injury crashes** might be achieved.
Benefit 2: Improve / maintain economic efficiency along SH1 (and SH29) corridor (30%)	It was considered in the workshop that up to **50% of the efficiency benefit could be achieved** through improvements to the 2 laning arrangements with passing lanes.

Cost and Time Ranges

The rough order cost range for Programme 3 is $1 million to $50 million.

This programme could be implemented within a 3 to 10 year timeframe.

Key programme risks and issues

The key risks associated with Programme 3 and its implementability are set out and assessed below.

As Programme 3 primarily focuses on on-line improvements to achieve the efficiency benefits and does little to improve safety. Therefore key risks relating to reputation and not meeting the expectations in terms of addressing the safety problems, consistency with and compromising the wider benefits of the Waikato Expressway, as well as risks and acceptance relating to access to local amenities are considered significant under this programme.

Operational	
• With people continuing to use other routes more Police resources required to monitor and enforce	Low-Med
Stakeholder	
• Organisational reputation relating to expectations for SH1 as a national route, and not meeting the safety objectives	**High**
Safety	
• The safety objectives will not be met	**High**
• Potentially introduces new safety issues	Med
• Potentially could increase running speeds along this section	Med
• There would still be conflicts between local and inter-regional traffic	Med
Economic	
• The shift in traffic to the Expressway corridor from alternative SH27 and SH2 routes may be marginal, and not achieve the full potential	Med
Accessibility & Social Inclusion	
• Accessibility to local areas/amenities would be reduced/restricted at some locations	Med
• May not be able to access certain parts of the Lake Karapiro and the associated recreational use with restricted turns and higher traffic volumes	**Med-High**

Programme 4 – Off-line Local Access Roads

Programme 4 is concerned with rationalising the number of accesses to the state highway and thereby reducing the conflicts between local and inter-regional traffic, and hence reduce the safety issues and impedance caused. Indicatively this would consider retaining the alignment of the existing state highway and providing off-line local access roads connecting key areas, service lanes, and restricted access/turning movements.

As such this programme option would deliver some benefits in terms of safety (up to 30%) and efficiency (50% to 70%). Primarily focussing on local access and intersections this programme falls short of addressing other the key safety problems related to loss of control on bends and straights and head-on impacts.

Performance against achieving investment benefits

Benefit 1: Improving safety (70%	With scope to reduce and/or manage the conflicts between local and inter-regional traffic it was felt that a this programme could achieve a **reduction of up to 30% in fatal and serious injury crashes.**
Benefit 2: Improve / maintain economic efficiency along SH1 (and SH29) corridor (30%)	It was considered in the workshop that up to **50% or 70% of the efficiency benefit could be achieved**.

Cost and Time Ranges

The rough order cost range for Programme 4 is $5 million to $50 million.

This programme could be implemented within a 5 to 15 year timeframe.

Key programme risks and issues

The key risks associated with Programme 4 and its implementability are set out and assessed below.

While Programme 4 is expected to deliver some benefits in terms of both safety and efficiency, this will be some way short of the achieving the full benefits. Therefore, there are significant risks relating to not being seen to fully addressing the safety problem on the existing state highway alignment. As this programme option involves some off-line alignment risks concerned with the cost and funding, as well as environmental, cultural and technical challenges were also noted.

Technical	
• With hilly topography and the lake situated immediately adjacent to either side of the state highway this would be technically challenging	**Med-High**
Operational	
• Still left with existing state highway with sub-standard alignment, accesses, etc.	Med
• Higher maintenance costs associated with having both the existing state highway and the new carriageway	Med
Financial	
• Likely will require land take and property acquisition – therefore would be expensive	**Med-High**
Stakeholder	
• Likely will require land take and property acquisition – therefore significant risk over acceptability by residents and land-owners	**High**
• Likely to be culturally sensitive in terms of land requirements	**Med-High**
	Med-High

• Risk of obtaining stakeholder support	Med
• Risk of lower public security for local residents, land-owners and amenities	Med
• Reducing the amenity value of the area	
Environmental	
• Environmentally and culturally sensitive area	**Med-High**
Safety	
• Might not deliver safety benefits sought – would still need to look at safety improvements required along the existing state highway	**Med-High**
• May increase safety risk for cycling along this corridor	Med
Economic	
• Potential loss of productive land	Med

Programme 5 – Local Access/Use Focus (e.g. Safer Turning/Reducing Conflicts)

Focussing on relatively small scale on-line options to improve local access and use of local amenities, Programme 5 is expected to deliver around 20% to 30% of the potential safety benefit, and very little in terms of efficiency.

Performance against achieving investment benefits

Benefit 1: Improving safety (70%	Overall a **reduction of 20% to 30% in fatal and serious injury crashes** could be expected
Benefit 2: Improve / maintain economic efficiency along SH1 (and SH29) corridor (30%)	It was considered in the workshop that only **5% the efficiency benefit could be achieved**

Cost and Time Ranges

The rough order cost range for Programme 5 is $1 million to $5 million.

This programme could be implemented within a 3 to 6 year timeframe.

Key programme risks and issues

The key risks associated with Programme 5 and its implementability are set out and assessed below.

Programme 5 is expected to deliver only a moderate improvement to safety, and very in the way efficiency on the SH1 corridor. As such the key risks are concerned with the reputation of the organisation and not being seen to effectively addressing the problems, particularly relating to safety, but also future efficiency and local access. Stakeholders were also expressed concerned over losing the benefits gained from the completed sections of the Waikato Expressway.

Financial	
• Likely will require some land take and property acquisition – and could be expensive	Low
Stakeholder	
• Likely will require some land take and property acquisition – therefore likely to be subject to public acceptance issues	Low
• Possible organisational reputation risk relating to expectations of users over meeting journey outcomes for efficiency, safety and access	**High**

Safety	
• Might not deliver all the safety benefits sought (only focusses on turning conflicts and access issues)	**High**
• Improving access for local amenities and properties may attract more turning traffic thereby potentially eroding some of the potential gained benefits (safety and efficiency)	**High**
Economic	
• May compromise the achievement of efficiency benefits with combination of increasing levels of throughput traffic and possible speed management measures	**Med -High**
• Improving access for local amenities and properties may attract more turning traffic thereby potentially eroding some of the potential gained benefits (safety and efficiency)	**Med-High**
• Not achieving shift of traffic expected with expressway, including freight traffic from the SH27 corridor	Med
• Possibly compromise achieving the full benefits of the Waikato Expressway	Med
Accessibility & Social Inclusion	
• May not fully address issues relating to access	**Med-High**

Programme 6 – Do Maximum Off-line State Highway (Expressway Standard)

This programme option relates to providing a state highway at expressway standard along an off-line alignment to address current safety problems, and to cater future predicted traffic demands safely and efficiently. The existing state highway would be retained for local access. As such Programme 6 is expected to deliver around 90% of the safety benefits, and 90 to 100% of the efficiency benefits. However Programme 6 is expected to cost the highest.

Performance against achieving investment benefits

Benefit 1: Improving safety (70%)	With an expressway standard alignment and cross section, with fewer intersections on the new state highway this programme option would deliver **90% of the safety benefits**
Benefit 2: Improve / maintain economic efficiency along SH1 (and SH29) corridor (30%)	With an expressway standard state highway (assuming a 4 lane dual carriageway) there will be sufficient capacity to cater future demands and achieve **90% to 100% of the efficiency benefits**.

Cost and Time Ranges

The rough order cost range for Programme 6 is $200 million to $400 million.

This programme could be implemented within a 10 to 15 year timeframe.

Key programme risks and issues

The key risks associated with Programme 6 and its implementability are set out and assessed below.

Programme 6 is expected to perform well in terms of achieving both safety and efficiency benefits. However there are some risks that were considered significant by the stakeholders. These are primarily concerned with the off-line alignments and in particular with the cost and availability of funding, as well as environmental, cultural and technical challenges. In addition, given the timescales attached to this programme (10 to 15 years) there is a significant risk that relates to not addressing the short term safety problems.

Technical	
• Similar to Programme 4	**Med-High**
Operational	
• Similar to Programme 4	Med
Financial	
• Similar to Programme 4	**High**
• Given length of time to deliver project of this scale and complexity, it will be subject to a number of political and GPS cycles and therefore there is a risk over funding certainty	Med
• Given the scale of investment this would likely divert funding from other investment opportunities	**Med-High**
Stakeholder	
• Similar to Programme 4	**Med-High**
• Risk in obtaining community and stakeholder support	Med
Safety	
• Similar to Programme 4, and same as Do-Minimum in the short/medium term	**High**
• Safety problems and issues would still exist (and could get worse) in the short term and possibly medium term	**High**
Environmental	
• Same as Programme 4	**Med-High**
Economic	
• Similar to Programme 4, and same as Do-Minimum in the short/medium term	**Med-High**
• Efficiency and reliability problems would likely manifest in the medium term	Med
• Risk of moving the safety problem downstream and increasing the safety risk	Low-Med
Accessibility & Social Inclusion	
• Potential access issues in short/medium term related to possible safety measures	Low

Appendix E – Safety Assessment

Safety – Strategic Options/Actions with Indicative Interventions and Potential Impacts

Benefit	Strategic Option/Action	Indicative interventions	WEX Tie-In to Hickey Road	Hickey Road to Kentucky Road	Kentucky Road to SH1/SH29 Intersection	Potential Impact (% reduction) from HRRRG
Improve Safety	Reduce impact of **loss of control (straights and bends) / head on crashes** and **overtaking crashes**	Centreline / edge line treatment (e.g. wide centreline or wire rope barrier*)	✓	✓	✓	Wide centreline: 32% of DSI Median barrier*: 80 to 90% of DSI & 10% of minor
		Sealed shoulder widening	✓	✓	✓	14 to 35% (Ave 20%)
		Audio tactile profile road marking	✓	✓	✓	10 to 43% (Ave 25%)
		Review merge layouts & passing lane strategy		✓		10 to 25%
		Treatment of out of context curves (consistent alignment/radius)	✓	✓	✓	50% reduction in loss of control/head-on crashes
	Reduce the risk and occurrence of crashes **involving crossing and turning traffic at intersections and accesses**	Intersection treatment – at-grade & grade separated	✓	✓	✓	Requires more detailed understanding of issues to determine whether minor or transformational works are required, and hence potential benefits
		Rationalise of accesses with local access roads*	✓	✓		
		Restricted right turns*	✓	✓		
		Speed management on approaches	✓	✓		

* Potential trade-off and acceptance issues relating to local users and providing turn-around facilities

What does the short term mid-block safety programme look like?

		Safety Option 1 1m WCL 1.5m shoulders 3.5m lanes	Safety Option 2 1.5m WCL 1.5m shoulders 3.5m lanes	Safety Option 3 1.5m WRB & EB 1.5m shoulders 3.5m lanes	Safety Option 4 3m WRB & EB 1.5m shoulders 3.5m lanes	Safety Option 5 Targeted WRB &EB (50% of route) 3m WRB 1.5m shoulders 3.5m lanes
Expected reduction in Fatal crashes	From To	1 0.7	1 0.7	4 0.8	4 0.8	4 1.7
Expected reduction in Serious crashes	From To	2 1.4	2 1.4	5 1	5 1	5 2.2
Expected reduction in Minor crashes	From To	5 3.6	5 3.6	15 12	15 12	15 13
Expected reduction in non-injury crashes	From To	7 5	8 5.8	28 31	28 31	28 30
Rough order costs no contingency		**$11.5M**	**$12M**	**$45M**	**$46M**	**$24M**
ROC with 100% contingency		**$23M**	**$24M**	**$90M**	**$92M**	**$48M**
Likely safety benefits	10 years	$3.6M	$3.6M	$28M	$28M	$19M
Likely BCR (v ROC + contingency)	10 years	1.1	1.0	0.3	0.3	0.4
DSI saved per $100M		83	75	18	17	27

Safety – Possible Intersection Treatments at Highest Risk Intersections

Intersection	DSI	CR	PR	LoSS	High Risk	Treatment Philosophy	Short Term (less than 2 yrs)			Intermediate Term (2 to 10 yrs)			Long Term (greater than 10 yrs)		
Hydro Road (Priority T)	1.41	MH	H	III	Yes	Safe System Transformation	RIAWS/signs and markings			well separated left turn lane/ U-turn facility/ or roundabout			Grade Separated		
							Period	BCR	DSIs saved per $100m	Period	BCR	DSIs saved per $100m	Period	BCR	DSIs saved per $100m
							5 yrs	0.9		5 yrs	0.3		5 yrs	0	
							10 yrs	1.9		10 yrs	0.6		10 yrs	0	
							15 yrs	2.8		15 yrs	0.9		15 yrs	0.1	
							20 yrs	3.8	338	20 yrs	1.2	39 to 141	20 yrs	0.1	14
					ROC (100% contingency)		$0.3 M			$0.8 M to $8.0 M			$20.0 M		
Karapiro Road (Priority T)	1.06	M	H	IV	No (less than 4 injury crashes)	Safety Management	Improve visibility of side road with islands.			U – turn facility here or located further south in mid- block location – if midblock, then restrict movement to left in and left out			Roundabout		
							Period	BCR	DSIs saved per $100m	Period	BCR	DSIs saved per $100m	Period	BCR	DSIs saved per $100m
							5 yrs	0.3		5 yrs	0		5 yrs	0	
							10 yrs	0.5		10 yrs	0		10 yrs	0	
							15 yrs	0.8		15 yrs	0		15 yrs	0	
							20 yrs	1.0	254	20 yrs	0.1	21	20 yrs	0	13
					ROC (100% contingency)		$0.2 M			$4.0 M			$10.0 M		
SH29	2.2	H	H	IV	Yes	Safe System Transformation	Well marked and well separated left turn facility with larger radius. Could reduce Speed Limit (temporary)			Roundabout			Grade separated or offline arrangement		
							Period	BCR	DSIs saved per $100m	Period	BCR	DSIs saved per $100m	Period	BCR	DSIs saved per $100m
							5 yrs	0.2		5 yrs	0		5 yrs	0	
							10 yrs	0.3		10 yrs	0		10 yrs	0	
							15 yrs	0.5		15 yrs	0		15 yrs	0	
							20 yrs	0.7	275	20 yrs	0.1	26	20 yrs	0.1	22
					ROC (100% contingency)		$0.8 M			$10.0 M			$20.0 M		

Safety – Possible Intersection Treatments at Lower Risk Intersections

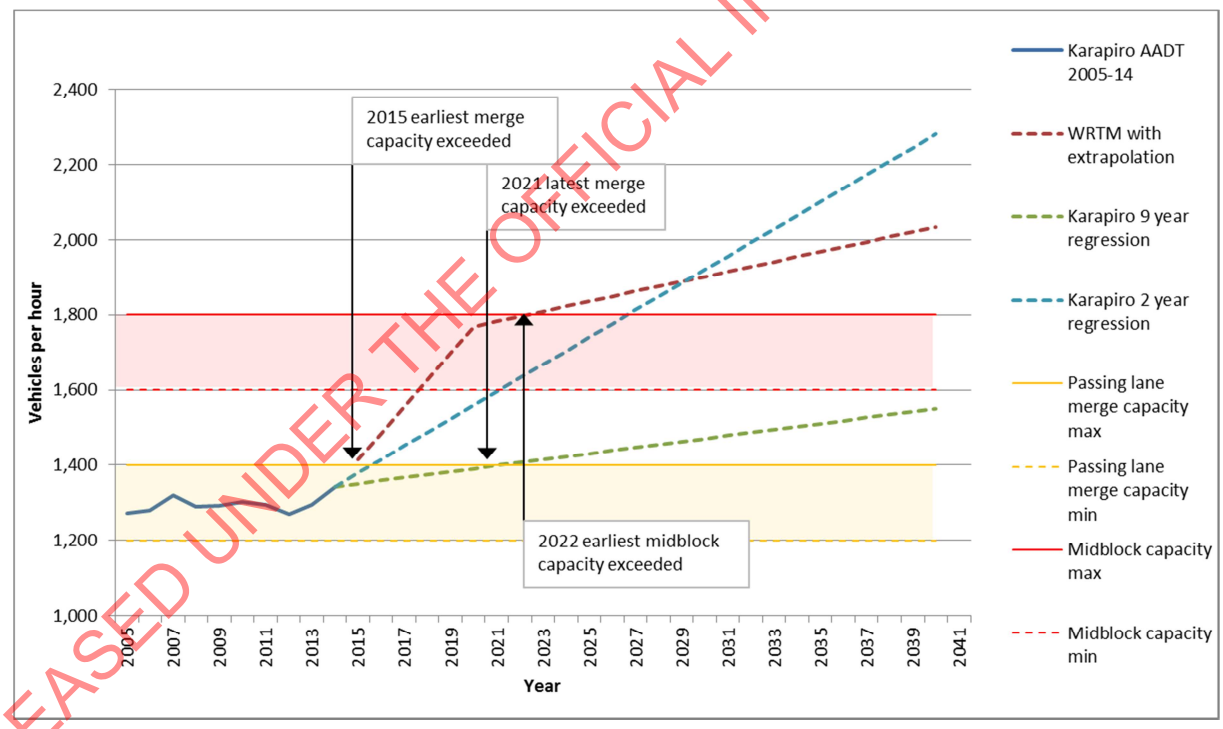
Intersection	High Risk	Short Term (less than2 yrs)	Intermediate Term (2 to 10 yrs)	Long Term (greater than 10 yrs)
Hickey Road (Priority T)	No	Nothing – slight modifications as part of weigh station design	Restrict to left in and left out	
Gorton Road (Priority T)	No	Nothing – well marked	Restrict to left in and left out	
Tunakawa Road (Priority T)	No	Nothing – low volume	Restrict to left in and left out	
Fergusson Gully Road (Priority T)	No	Improve intersection visibility and localised widening	Shorten passing lane and create right turn bay	Possible close and connect to Kentucky road
Keely's landing (uncontrolled)	No	Improve intersection visibility and localised widening – better signs for access	Install right turn bay	U – turn facility
Kentucky Road (Priority T)	No	Upgrade signs and markings	Rationalise intersection with Moana drive across the road.	U – turn facility
Maungatautari Road (Priority T)	No	Localised shoulder widening, improve skid resistance.	Remove passing lane and install wire rope barrier to the north and south	Grade separated or offline arrangement

Appendix F – Capacity Assessment

At this stage it is difficult to identify exactly when traffic levels will reach a point (say between 18,000 and 20,000 vpd) where traffic flows start breaking down significantly. The figures shown in this assessment reflect current forecasts based on the WRTM, and so will need to be monitored going forward particularly following the completion and opening of the Waikato Expressway. In an attempt to determine approximately when the capacity of this section of SH1 is likely to be exceeded, current peak hour flows[29] from 2005 to 2014 are compared to the midblock lane capacity and the passing lane merge lane capacity. Current flows fall within the upper and lower limits for passing lane capacity[30], and anecdotal instances of passing lane merge issues are known. Midblock lane capacity has not yet been reached.

Three scenarios of future flows are shown on Figure 10-2 and these are:

- Flows forecast from the 2005-2014 period, extrapolated at the same linear growth rate of 0.6% per annum.
- Flows forecast from the 2012-2014 period, extrapolated at the same linear growth rate of 2.8% per annum. Prior to 2012 traffic growth along this section of SH1 was very low, sometimes decreasing. Since 2012 however the traffic has grown noticeably in 2012, 2013, and 2014. The average growth over this period is extrapolated.
- WRTM forecasts at 2021 and 2041, which has a linear growth rate of 0.8% per annum and which is similar to the historical 9-year growth along the corridor. Between 2014 and 2021 however the growth rate is much higher at around 5%. This reflects the attraction to the SH1 expressway from routes such as SH2 and SH27, although the growth appears quite high. As mentioned previously the land use expected in the upcoming version of the WRTM is likely to be at lower levels that are currently forecast and this may have an impact on these rates of growth.



Comparing these growth rates to the lane capacities an approximate date when the corridor reaches capacity can be identified. Based on the different growth rates the upper limit of the passing lane capacity is reached between 2015 and 2021. The worst case scenario for midblock capacity is based on WRTM flows, and the estimated date when capacity is reached is 2022, or 2027 using the 2.8% growth rate.

[29] Historical two way hourly counts at the Karapiro telemetry station, halved.

[30] The assessment has been carried out by using observed two-way AADT divided in half. WRTM all day flows have been converted to hourly flows by dividing by 10 (i.e. 10% of AADT) and then divided in half to establish a one-way flow. More detailed analysis is required for a more accurate assessment..

It should be noted that **these growth rates are subject to variation and therefore there is a risk that these dates are not certain.** Monitoring of traffic flows, journey times, levels of congestion, and crash statistics should be carried out to increase the confidence in the growth rates and future forecasts.

Efficiency – Strategic Options/Actions and Indicative Interventions

Benefit	Strategic Option/Action	Indicative interventions
Maintain / improve economic efficiency along the existing SH1 corridor while catering for future travel demands	Improve level of service of current 2 lane + passing lanes arrangement (minor works)	Review existing passing lane performance
		Improve passing lane merge layouts
		Increase turning radii on out of context curves
	Manage conflicts with local users and side road impedance traffic	Reduce conflicts (e.g. restricted right turns)*
		Reduce number of intersections/accesses*
		Grade separated intersections
		Local access roads
	Increase capacity (transformational)	On-line 4 laning
		Partial 4 laning / local access roads

* Potential trade-offs, and acceptance issues relating to local users and providing turn-around facilities

Appendix G – Cost Estimation

Programme Cost estimates

Cost ranges are sourced from the Sin A Model, provided by NZ Transport Agency

Indicative treatment	Combined 2&3 Improve 2 lane and passing lanes				Alternative 2&3 On-line safety and capacity				Do Max Off-line Expressway standard				SH1/29 Interchange			
	No	km	lower cost ($M)	upper cost ($M)	No	km	lower cost ($M)	upper cost ($M)	No	km	lower cost ($M)	upper cost ($M)	No	km	lower cost ($M)	upper cost ($M)
median treatment		17	25.500	25.500		17	25.500	25.500								
additional lanes					17		61.200	136.000								
intersections	4		12.000	12.000	6		18.000	18.000								
interchanges					5		184.000	184.000	3		110.400	110.400	1		36.800	36.800
local access roads		4	29.600	29.600	10		74.000	74.000		4	29.600	29.600		1	7.400	7.400
bypass										17	125.800	377.400		2	14.800	44.400
passing lanes		3	10.800	24.000												
road realignment					3		5.400	13.200		3	5.400	13.200				
safety improvements		17	0.680	0.680												
			78.580	91.780			368.100	450.700			271.200	530.600			59.000	88.600
	Cost range		80	90	Cost range		370	450	Cost range		270	530	Cost range		60	90
	assume: 17km median treatment 17km on-line safety improvements upgrade intersection at Maungatautari Rd upgrade intersection at Gorton Rd upgrade intersection at Hydro Rd upgrade intersection at Karapiro Rd 4km of local road to rationalise accesses additional passing lane				assume: 17km with additional lanes SH1/29 interchange Karapiro Rd interchange Hydro Rd, Gorton Rd, Maungatautari Rd interchanges other 6 intersections upgraded 10km of local road to rationalise accesses 1km eastern and western curve realignment				assume: SH1/29 interchange interchange serving Karapiro Rd and Gorton Rd interchange serving Hydro Rd 1km western curve realignment 2km eastern curve realignment				assume: SH1/29 interchange 0.5km SH29 realignment 1km SH1 out of context curve realignment 0.5km SH1 south realignment 1km local road/access realignment			

SinA average values

Type of project	BCR	cost/km ($M)
additional lanes (block)	8.9	$ 3.600
additional lanes (large)	10.7	$ 8.000
interchanges	1.9	$ 36.800
intersections	3.5	$ 3.000
median treatment	2.7	$ 1.500
new links/bypass	2.3	$ 7.400
new links/bypass RONS	1.6	$ 22.200
passing lanes	2.6	$ 1.500
road realignment (block)	3.1	$ 1.800
road realignment (large)	2.1	$ 4.400
safety improvements	12	$ 0.040

Appendix H – Programme Funding

		2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
Activity 1 On-line Safety																						
IBC																						
upper	$2M		2																			
lower	$1M		1																			
DBC																						
upper	$3M			3																		
lower	$1.5M			51.5																		
Pre-implementation and Implementation																						
upper	$95M				31.7	31.7	31.7															
lower	$47.5M				15.8	15.8	15.8															
Activity 1 On-line Safety total																						
upper	$100M		2	3	31.7	31.7	31.7															
lower	$50M		1	1.5	15.8	15.8	15.8															
Activity 2 SH1/29 Intersection																						
IBC																						
upper	$1.8M		0.9	0.9																		
lower	$1.2M		0.6	0.6																		
DBC																						
upper	$2.7M				1.3	1.3																
lower	$1.8M				0.9	0.9																
Pre-implementation and Implementation																						
upper																						
lower																						
Activity 2 SH1/29 Intersection																						
upper	$5M		0.9	0.9	1.3	1.3																
lower	$3M		0.6	0.6	0.9	0.9																

		2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
Activity 3 Longer Term Efficiency																						
IBC																						
upper	$8.8M		2.9	2.9	2.9																	
lower	$4.2M		1.4	1.4	1.4																	
DBC																						
upper	$13.2M					3.3	3.3	3.3	3.3													
lower	$6.3M					1.6	1.6	1.6	1.6													
Pre-implementation and Implementation																						
upper	$503.5M									67.0	77.0	83.9	90.9	90.9	90.9							
lower	$256.5M									36.1	39.4	42.7	46.1	46.1	46.1							
Activity 3 Longer Term Efficiency total																						
upper	$530M		9	9	9	14	14	14	14	62	70	78	86	86	86							
lower	$270M		4	4	4	6	6	6	6	28	32	35	39	39	39							
Programme total																						
upper	$630M		14	19	38	42	42	14	14	62	70	78	86	86	86							
lower	$320M		7	9	18	20	20	6	6	28	32	35	39	39	39							

Assume: IBC is 2% of cost, DBC is 3% of cost and Pre-implementation and Implementation is 95% of cost