ŌTAKI TO NORTH OF LEVIN PFRs

Report No. 11: Route Improvements Report

Prepared for NZ Transport Agency

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Executive Summary

This report examines the feasibility of undertaking various area-wide safety and efficiency improvements on the sections of State Highway 1 and State Highway 57 through the Ōtaki to north of Levin study area. These improvements focus on roadside treatments (including sealed shoulder widening and barrier protection), passing lanes, rural accessways, rural intersections (layout, form and features), and walking and cycling facilities.

The contents of this report should be considered alongside the other project feasibility reports and the four laning report to determine the best package of improvements to progress as the first stage in the long term strategy.

Cost estimates and economics detailed within this report are rough order estimates and need further development before being considered with any confidence.

NZ Transport Agency

Report 11: Route Improvements Report

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1 Introduction

Using the outcomes of the Ōtaki to North of Levin Scoping Report and addendum, the NZTA decided that the most appropriate strategy for the highway between Ōtaki and north of Levin is to upgrade the existing highways as the first stage of a long term strategy. This allows the NZTA to realise important safety benefits in the short to medium term whilst deferring the need to construct four lanes for the time being.

This report is one of a number of reports being undertaken to determine the package of improvements that should be implemented to improve the safety and efficiency of the highway between Ōtaki and north of Levin as part of the Wellington Northern Corridor Road of National Significance (RoNS).

The objectives of the Wellington Northern Corridor RoNS, which runs from Wellington Airport to north of Levin, are:
To enhance inter regional and national economic growth and productivity;
To improve access to Wellington's CBD, key industrial and employment centres, port, airport and hospital;

- To provide relief from severe congestion on the state highway and local road networks;
- To improve the journey time reliability of travel on the section of SH1 between Levin and the Wellington Airport; and
- To improve the safety of travel on state highways

For the Ōtaki to north of Levin section; the objectives are:
To provide best value solutions which will progressively meet (via a staged approach) the long term RoNS goals for this corridor of achieving a high quality four lane route;
To provide better Levels of Service, particularly for journey time and safety, between north of Ōtaki and north of Levin;
To remove or improve at-grade intersections between north of Ōtaki and north of Levin;
To engage effectively with key stakeholders; and
To lodge Notices of Requirement and resource consents as appropriate with the relevant consent authorities for the first individual project by the 2013/14 financial year.

The projects that are being developed to help meet these objectives are presented in Section 2.

The purpose of this report is to determine the feasibility of undertaking area-wide safety and efficiency improvements on the sections of State Highway 1 and State Highway 57 through the study area. It specifically investigates improvements in the following areas:

- Edge Treatment in Section 4, such as shoulder widening and edge barrier
- Passing Lanes in Section 5
- Side Friction in Section 6, such as private, farm, and commercial driveways and accessways
- Side Roads in Section 7
- Vertical Profile in Section 8
- Walking and Cycling in Section 9

For each of the above areas, the current deficiencies have been determined and projects identified to address the deficiencies where appropriate. Where applicable, each improvement has been considered as a series of isolated individual improvement projects with separate costs, this allows for individual projects to be considered, whilst later gaining extra potential benefits from economies of scale.

Some outcomes of this report may have also been considered within the ten specific Project Feasibility Reports (PFRs).

The outcome of this report will be considered alongside the outcomes of the PFRs and used to determine the best package of works to progress as the first stage of the long term strategy between Ōtaki and north of Levin.

2 Projects Currently Being Investigated

The projects that are currently being investigated to meet the short to medium term objectives of the Ōtaki to north of Levin RoNS project are presented in the figure below.

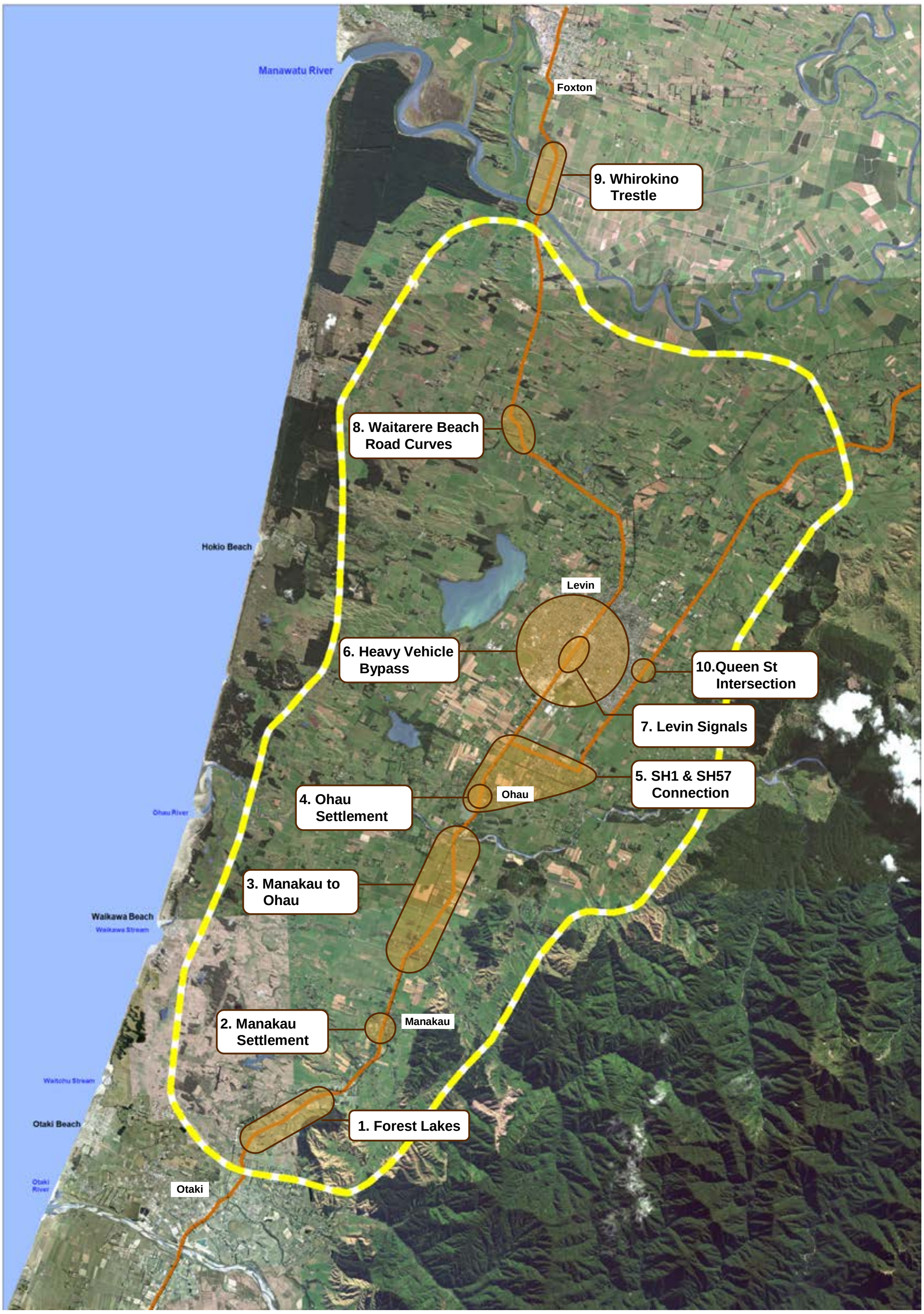

Figure 2-1: Projects Currently Being Investigated

In addition to the above PFRs, reports are also being undertaken on Route Improvements (this report) and Four Lane Alignments (Report No 12).

3 Existing Highways

The existing highways in the study area include the section of SH1 from Taylors Road intersection, RP 1N/995/3.30, north through Levin to just south of the Manawatu River at RP 1N/967/0.50. This section of SH1 has a length of 31.4 km. Also included is a section of SH57, from the beginning (intersection with SH1) at RS 0/0 to Rolston's Corner Rest Area at RP 0/14.31. This section of SH57 has a length of 14.3 km.

3.1 Description and Function

3.1.1 State Highway 1

SH1 is classified as 'National Strategic High Volume' from Wellington to Levin and 'National Strategic' from Levin to Taupo in the NZTA's highway classification system[1].

SH1 through the study area is generally a two lane two way road that passes through rural and urban sections from north of Ōtaki to the Manawatu River Bridge. It follows the historic route established in the late 19th and early 20th centuries. As a consequence, it is constrained by a below standard seal width, substandard horizontal and vertical alignment, towns and settlements, narrow bridges on tight curves, in parts the rail alignment, and significant side friction caused by local roads.

The topography of the route is generally flat with some moderately hilly sections mainly at the southern end. This section of SH1 passes through the township of Levin, and settlements of Ohau and Manakau. The speed limit is 100 km/h, except in the urban and peri-urban areas of Levin, where 80, 70 and 50 km/h speed limits apply variously.

SH1 through the study area provides access between Wellington (and the South Island) and a major part of the remainder of the North Island. It connects locations of national economic significance in an area where there are no practicable alternative highway routes.

There is no parallel route available so SH1 is also a crucial lifelines route.

SH1 also provides access to numerous rural farm and residential properties, rural selling places and acts as a spine road for many local roads.

3.1.2 State Highway 57

SH57 is classified as a 'National Strategic' route in the highway classification system.

SH57 commences at its junction with SH1 at Kimberley Road, south of Levin and proceeds east to Arapaepae Road, which it meets at a 90 degree angle. It then follows Arapaepae Road north, passing east of Levin and continuing on towards Shannon, Palmerston North and the eastern North Island via other State Highways.

The topography of the route within the study area is generally flat. It has two traffic lanes with the exception of a northbound passing lane north of Potts Road. The speed limit is 100 km/h throughout the study area.

SH57 serves as the primary southern link between SH1 and Palmerston North. As such it carries a high proportion of commuter traffic between Palmerston North and Horowhenua. Also, most of the freight movements between Wellington and Palmerston North and other regions to the east of the Manawatu Gorge use SH57 as an arterial route.

SH57 also provides access to numerous rural farms and residential properties, as well as a few rural selling places and acts as a spine road for many local roads.

[1] NZTA's State Highway Classification http://www.nzta.govt.nz/planning/process/doc/final-classification.pdf

3.2 Traffic Statistics

The Average Annual Daily Traffic Volumes (AADTs), as determined by the NZTA, vary significantly throughout the study area as shown below:

Table 3-1: 2011 AADTs on State Highways

State Highway	Reference Station	Route Position	Location	AADT (2011)	Percentage Heavies
1	985	3.48	Ohau (Telemetry)	14,600	13.8%
1	967	17.27	South of Levin	11,500	7.0%
1	967	13.58	Central Levin	13,400	9.0%
1	954	11.12	Whirokino	7,800	10.1%
57	0	1.8	Near SH1	4,500	11.3%
57	0	9.6	North of Levin (near Tavistock Road)	7,800	9.1%

Traffic growth has been calculated at the Ohau telemetry site. For the period 1992 to 2011, the annual traffic growth has been approximately 1.4% per annum. The numbers of heavy vehicles have increased by approximately 2% per annum. The rise in fuel prices and the global economic downturn have resulted in fewer trips being made over the last few years, with the easing of fuel prices the number of trips is no longer falling. The implications of this would need to be more thoroughly researched at the SAR stage.

4 Edge Treatment

Edge Treatment in the context of this report is shoulder width, hazard removal, clear zones, drainage and other treatments which do not occur on the road carriageway.

The purpose of this part of the report is determine the level of edge treatment provided by the existing highways in regards to shoulder widths and clear zones and propose and prioritise projects to address the current deficiencies.

4.1 Existing Situation

The NZTA's RAMM database contains data for carriageway seal and lane width. However this information is the average width for long segments of highway and does not accurately reflect widening for accessways or on curves. Additionally as there is a sealed shoulder on each side of the highway, only an average of the two shoulder widths can be determined, hence this may not reflect a wide shoulder on one side of the highway compared with a narrow shoulder on the other.

The two state highways within the study area were surveyed in 2008 for KiwiRAP; one of the measurements taken was the sealed shoulder width, with other measurements including offset from the edge line and severity of roadside hazards on both sides of the carriageway.

Sealed shoulder width was reported in KiwiRAP as the minimum sealed shoulder width on either side of the highway for a 100 m segment of highway, within six bands; no edge line, 0 - 0.6 m, 0.6 - 1.2 m, 1.2 - 1.7 m, 1.7 - 2.4 m, and > 2.4 m.

KiwiRAP measures the likely severity of crashes when striking a hazard and the proximity of the hazard to the roadway, to place the roadside environment in one of four categories from Low (negligible) to High (severe).

The Star Rating is a measure of how a road section performs considering all recorded engineering features, a low (1) Star Rating represents a road with poor safety; and a high (5) Star Rating represents a road with excellent safety. The proposed state highways levels of service aim for national strategic high volume highways to have a Star Rating of 4 or higher. The aim is for national strategic highways to achieve a 3 or 4 Star Rating except where confined within an adverse alignment, such as the Manawatu Gorge. The majority of the sections detailed in Table 4-1 are below the level of service targets.

Table 4-1: KiwiRAP Sealed Shoulder Width and Clear Zone Characteristics

Section Extent	Minimum Sealed Shoulder Width					Roadside Hazard Risk				Star Rating
	<0.6 m	0.6 – 1.2 m	1.2 – 1.7 m	1.7 – 2.4 m	>2.4 m	Negligible	Minor	Moderate	Severe	
SH1: Forest Lakes 995/3.3 - 995/0.1	-	63%	38%	-	-	2%	17%	63%	19%	3.2
SN1N: Pukehou Overbridge to Manakau* 995/0.1 – 985/9.0	21%*	53%*	26%*	-	-	4%*	7%*	58%*	31%*	2.6*
SH1: Manakau to Manakau Rail Overbridge 985/9.0 - 985/7.0	20%	55%	25%	-	-	8%	10%	28%	55%	2.7
SH1: Manakau Rail Overbridge to Ohau River (Bridges Inclusive) 985/7.0 - 985/3.0	53%	38%	10%	-	-	1%	15%	29%	55%	2.6
SH1: Ohau River to Bishops Road 985/3.0 - 985/2.3	-	86%	14%	-	-	14%	29%	57%	-	2.3
SH1: Ohau Township 985/2.3 - 985/1.0	15%	31%	54%	-	-	12%	-	50%	38%	2.4
SH1: Vista Road to Kimberley Road 985/1.0 - 985/0.0	-	60%	40%	-	-	-	-	50%	50%	2.8
SH1: Kimberley Road to Levin 967/15.9 – 967/17.4	-	93%	7%	-	-	-	-	40%	60%	2.8
SH1: Levin to Waitarere Beach Road 967/5.9 - 967/11.7	3%	78%	19%	-	-	-	-	52%	48%	2.6
SH1: Waitarere Beach Road to Manawatu Bridge (Whirokino) 967/0 - 967/5.9	3%	90%	7%	-	-	8%	8%	65%	19%	3.3
SH57: SH1 to Arapaepae Road (Kimberley Road) 0/0.0 - 0/2.1	86%	14%	-	-	-	-	-	45%	55%	2.2
SH57: Kimberley Road to Queen Street East 0/2.1 - 0/5.6	-	-	51%	49%	-	-	13%	41%	46%	3.1
SH57: Queen Street East to Tavistock Road 0/5.6 - 0/10.0	-	5%	48%	43%	5%	2%	13%	33%	52%	3.2
SH57: Tavistock Road to Rest Area 0/10.0 - 0/14.3	-	65%	35%	-	-	7%	33%	44%	16%	3.4

* Improvements to the alignment and shoulder widths from the Waiauti Stream Realignment carried out in 2010 have not been updated within KiwiRAP and so are not accurately represented in this table.

4.2 Crash History

Table 4-2 below outlines rural crashes for movements AD, C*, and D* as outlined by the high risk rural roads guide for run-off-road crashes. Crash movements other than Run-off-road can result in vehicles hitting roadside hazards resulting in death and serious injury to the vehicle occupants. Table 4-3 outlines the 5 most commonly struck objects within the study area, it should be noted that fences and traffic signs are impractical to treat.

Table 4-2: Rural Run off Road Crashes 2007-2011

Year	Fatal	Serious	Minor	Non-Injury	Total	DSI
2007	1	4	5	22	**32**	6
2008	1	1	6	18	**26**	3
2009	1	1	10	12	**24**	2
2010	-	1	14	11	**26**	1
2011	-	4	10	9	**23**	4
Total	**3**	**11**	**45**	**72**	**131**	**16**

Table 4-3: Most Common Objects Struck in Rural Crashes

Object	Fatal and Serious	Injury	Total	DSI	Multiple Objects
Fence	4	28	70	4	57%
Ditch	4	15	35	4	40%
Tree	6	11	22	8	73%
Pole	5	13	20	6	70%
Signs	2	4	13	3	77%
All Objects	**22**	**71**	**169**	**29**	**33%**

It should be noted that a single crash can hit multiple objects, hence when Table 4-3 and Table 4-4 are compared there are more object struck crashes.

Other objects hit involving death and serious injuries were; upright banks, debris, guardrail, and workmen's and other parked or broken down vehicles. Whilst a relatively small proportion of fence crashes hit other objects (compared with trees, poles, and signs) fences were struck in 70% of all crashes in which multiple objects were hit. Table 4-4 shows the numbers of crashes hitting treatable and protectable objects.

Table 4-4: Rural Crashes (2007-2011) hitting Poles, Trees, Ditches

Year	Fatal	Serious	Minor	Non-Injury	Total	DSI
2007	-	4	-	13	**17**	5
2008	1	-	4	9	**14**	1
2009	2	1	4	5	**12**	5
2010	-	2	8	5	**15**	2
2011	-	2	6	4	**12**	2
Total	**3**	**9**	**22**	**36**	**70**	**15**

Sealed shoulder widening provides a wider area for drivers wh have lost control to recover, resulting in fewer and a lower severity run-off-road crashes. There is also a reduction in head on crashes due to the increased avoidance width.

4.3 Strategy

The Roads of National Significance standards require sealed shoulders of at least 2.5 m on the left hand side and 1.0 m on the right hand side prior to the median strip; however this standard is not considered to be economically viable as part of the staged upgrade of the highway due to capital outlay and the potential for redundancy with later stages. Therefore a revised standard for these roads in the short term is recommended, which is still consistent with desired safety gains and link width. The strategy for Ōtaki to north of Levin will be to provide a 2.0 m shoulder on both sides of an undivided carriageway, and 1.0 m (or the maximum deflection of the median barrier, whichever is larger) on the right for divided carriageways. 2.0 m has been chosen for the effectiveness of safety benefits as well as for walking and cycling as discussed in Section 9.

The strategy also includes progressively providing safety barriers as appropriate. Rigid, semi-rigid, and flexible safety barrier systems achieve benefits similar to large clear zones without the negative psychological effect of a wide open space encouraging drivers to increase speeds and the increased requirement for land take. Ideally all hazards would be protected using wire rope systems as these provide the best rates of reducing death and serious injury; however due to the increased deflections that these systems incur, this solution is not desirable for hazards such as bridges and under or overpasses and poles in close proximity to the carriageway.

4.4 Alternatives and Options Considered

Various seal widths and edge treatments have been considered.

Providing a consistent sealed shoulder width of 2.0 m is expected to reduce injury crashes by 5.3%, as calculated through KiwiRAP analysis. Increasing this width to 2.5 m only provides an additional 0.2% reduction in injury crashes. Accordingly, the extra safety benefit of widening to 2.5 m is not tangibly beneficial based on KiwiRAP. In addition, the NZTA recommended link width for the section of SH1 from Ōtaki to the SH1/57 intersection lane includes a nominal 11 m seal width, hence 2.0 m sealed shoulders and non-quantitative benefits (such as easier access to properties) are well catered for. The assessment of 2.0 m sealed shoulders has not been based on traffic volumes.

Clear zones are expensive as they require removal or relocation of hazards and width to be effective. They psychologically encourage increased speeds through the appearance of space resulting in potential for more severe crash outcomes. Clear zones do, however, have the benefit that they do not require gaps for intersections and accessways.

Wire rope barrier provides the most balanced edge protection and overall significantly decreases the severity of crashes by dissipating the crash energy through deflection and absorption. However, wire rope barrier deflection means that it cannot provide full protection of some hazards and is in itself a known hazard, as are all barrier systems.

Guardrail with either wooden or steel driven posts protects against severe hazards whilst deflecting less. Guardrail provides protection to reduce deaths and serious injuries, with smaller reduction to minor injury crashes. While other barrier systems exist with lower rates of severe crashes, guardrail provides the most consistent treatment in a balanced manner which is applicable for the entire study area where this type of treatment is required.

Whilst all hazards which could cause death or serious injury should be removed or protected with guardrail, this is not always entirely practicable as vehicle speed and chance can play a significant role in crash severity. Therefore those hazards which are likely to cause death and serious injury (such as power poles, large trees, ditches, and cliff drop offs) located within 4 m of the edge line should be removed or protected. This is roughly the definition of severe hazards within KiwiRAP. The level of hazard protection considered to be required is based on the KiwiRAP model and the benefits of this treatment as well as sealed shoulder widening are shown in Table 4-7. When applied across the entire study area there is a predicted 20% reduction in injury crashes.

Audio-tactile pavement (ATP) markings return slight benefits under this type of analysis with an injury crash rate reduction of 1% when applied across the entire route. This has not been considered further due to the marginal benefits but ATP markings could be considered for specific improvement projects.

4.5 Cost Estimates

Indicative construction costs for edge protection are outlined below in Table 4-6. The rates for these required works are shown in Table 4-5 below. These rates and costs are only indicative construction costs and do not take into account on-going maintenance or repair work on the wider shoulders or edge protection. These estimated rough order costs have been compiled based on two local projects where rates could be extracted or derived.

This has resulted in carriageway widening cost of $500,000 per kilometre, which reflects that up to 4 m of widening (highly unlikely) could be required for both side of the state highway carriageway. If less than 1 m of carriageway widening is required, the cost has been taken at two thirds of this rate which reflects other costs such as drainage and traffic management which occur regardless of how much widening is required.

Edge protection of guardrail has been calculated based on the Rimutaka Barriers minor safety works project cost. This includes traffic management and other costs associated with installation. This guardrail is on quite demanding terrain with frequent start and end terminals which reflects the many accessways that are present within the study area.

For now risk has not been factored into the estimates.

Table 4-5: Estimated Construction Cost Rates

Item	Estimated Construction Cost
Carriageway sealed shoulder widening, less than 1 m	$333,000/km
Carriageway sealed shoulder widening, greater than 1 m	$500,000/km
Guardrail (single side)	$400,000/km

Table 4-6: Esitmated Construction Costs

Section Extent	Shoulder Widening <1 m	Shoulder Widening >1 m	Guardrail	Estimated Construction Cost (000's)
SH1: Forest Lakes 995/3.3 - 995/0.1	1.2 km	2.0 km	1.2 km	$1,880
SN1N: Pukehou Overbridge to Manakau* 995/0.1 – 985/9.0	0.6 km	1.7 km	1.4 km	$1,600
SH1: Manakau to Manakau Rail Overbridge 985/9.0 - 985/7.0	0.5 km	1.5 km	2.2 km	$1,800
SH1: Manakau Rail Overbridge to Ohau River (Bridges Inclusive) 985/7.0 - 985/3.0	0.4 km	3.6 km	4.4 km	$3,690
SH1: Ohau River to Bishops Road 985/3.0 - 985/2.3	0.1 km	0.6 km	-	$330
SH1: Ohau Township 985/2.3 - 985/1.0	0.7 km	0.6 km	1.0 km	$930
SH1: Vista Road to Kimberley Road 985/1.0 - 985/0.0	0.4 km	0.6 km	1.0 km	$830
SH1: Kimberley Road to Levin 967/15.9 – 967/17.4	0.1 km	1.4 km	1.8 km	$1,460
SH1: Levin to Waitarere Beach Road 967/5.9 - 967/11.7	1.1 km	4.7 km	5.6 km	$4,960
SH1: Waitarere Beach Road to Manawatu Bridge (Whirokino) 967/0 - 967/5.9	0.4 km	5.5 km	2.3 km	$3,800
SH57: SH1 to Arapaepae Road (Kimberley Road) 0/0.0 - 0/2.1	-	2.1 km	2.3 km	$1,970
SH57: Kimberley Road to Queen Street East 0/2.1 - 0/5.6	1.8 km	-	3.2 km	$1,880
SH57: Queen Street East to Tavistock Road 0/5.6 - 0/10.0	2.1 km	0.2 km	4.6 km	$2,640
SH57: Tavistock Road to Rest Area 0/10.0 - 0/14.3	1.5 km	2.8 km	1.4 km	$2,460
Total Package	**10.9 km**	**27.3 km**	**32.4 km**	**$30,240**

4.6 Economic Assessment

Only the crash savings economic benefits have been calculated as other benefits will be negligible. The economic benefits of shoulder widening have been assessed as the reduction in injury crashes using the KiwiRAP model and given in the High Risk Rural Roads Guide.

The cost of injury accidents has been taken from Table A6.22 of the EEM using "All other sites" and "100 km/h near rural" and adjusted using the 2011 update factor. Near Rural is defined as being within 20 km of a population centre with 3,000 people or more.

The annual crash savings value has been adjusted using a uniform series present worth factor for 30 years at an 8% discount rate.

Table 4-7: Edge Treatment Benefits

Section Extent	Actual Annual Injury Crashes	Extent Star Rating	Current Expected Annual Injury Crashes	Proposed Star Rating	Proposed Expected Annual Injury Crashes	Total Estimated Benefits (000's)	Estimated BCR
SH1: Forest Lakes 995/3.3 - 995/0.1	2.2	3.2	3.6	3.4	3.0	$4,210	2.2
SN1N: Pukehou Overbridge to Manakau* 995/0.1 – 985/9.0	2.2	2.6	3.5	2.8	2.9	$4,400	2.8
SH1: Manakau to Manakau Rail Overbridge 985/9.0 - 985/7.0	1.8	2.7	3.1	3.0	2.3	$5,430	3.0
SH1: Manakau Rail Overbridge to Ohau River (Bridges Inclusive) 985/7.0 - 985/3.0	3.0	2.6	6.0	3.0	4.2	$12,400	3.4
SH1: Ohau River to Bishops Road 985/3.0 - 985/2.3	-	2.3	1.1	2.4	1.0	$254	0.8
SH1: Ohau Township 985/2.3 - 985/1.0	1.0	2.4	2.2	2.5	1.9	$1,880	2.0
SH1: Vista Road to Kimberley Road 985/1.0 - 985/0.0	1.8	2.8	1.4	3.1	1.1	$2,430	2.9
SH1: Kimberley Road to Levin 967/15.9 – 967/17.4	0.8	2.8	1.8	3.3	1.3	$4,070	2.8
SH1: Levin to Waitarere Beach Road 967/5.9 - 967/11.7	3.6	2.6	5.7	2.9	4.1	$11,100	2.2
SH1: Waitarere Beach Road to Manawatu Bridge (Whirokino) 967/0 - 967/5.9	1.4	3.3	3.5	3.6	2.8	$5,110	1.3
SH57: SH1 to Arapaepae Road (Kimberley Road) 0/0.0 - 0/2.1	0.8	2.2	1.0	2.4	0.7	$2,250	1.1
SH57: Kimberley Road to Queen Street East 0/2.1 - 0/5.6	1.2	3.1	1.3	3.5	0.9	$2,730	1.5
SH57: Queen Street East to Tavistock Road 0/5.6 - 0/10.0	2.6	3.2	2.8	3.7	1.9	$6,660	2.5
SH57: Tavistock Road to Rest Area 0/10.0 - 0/14.3	2.4	3.4	2.4	3.7	1.9	$3,270	1.3
Total Package	**25.4**	**2.8**	**39.4**	**3.2**	**30.1**	**$66,200**	**2.2**

The above project benefits were estimated using a predictive method, rather than the traditional reactive prescription from the EEM.

4.7 Other Aspects

Additional benefits will be gained from providing adequate shoulder space for an on-road cyclists (see the Walking and Cycling section).

Edge protection guardrail is an effective measure of physically closing unauthorised and additional accessways on multiple access properties (see the Side Friction section).

Wire rope barriers were not considered during the economic assessment as they are not suitable in all environments due to the deflection when struck. However at individual locations a wire rope barrier system could be suitable and consideration should be given to wire rope as a feasible treatment measure.

4.8 Conclusions and Recommendations

The above analysis shows that providing wider shoulders and edge protection can provide significant safety benefits. Greater benefits are available on SH1 south of Levin where the traffic volumes are higher and north of Levin, as far as Waitarere Beach Road, due to the current carriageway form.

5 Passing Lanes

The purpose of this part of the report is determine the number and location of passing lanes required to deliver an improved level of service for road users on the existing highways in the study area.

5.1 Existing Situation

NZTA guidelines recommend that passing lanes should have an absolute minimum length of 800 m. Many older passing lanes are often shorter than this requirement, and passing lanes are sometimes shortened to avoid dangerous situations such as a side road junction or significant accessway near the end of the passing lane or on the passing lane.

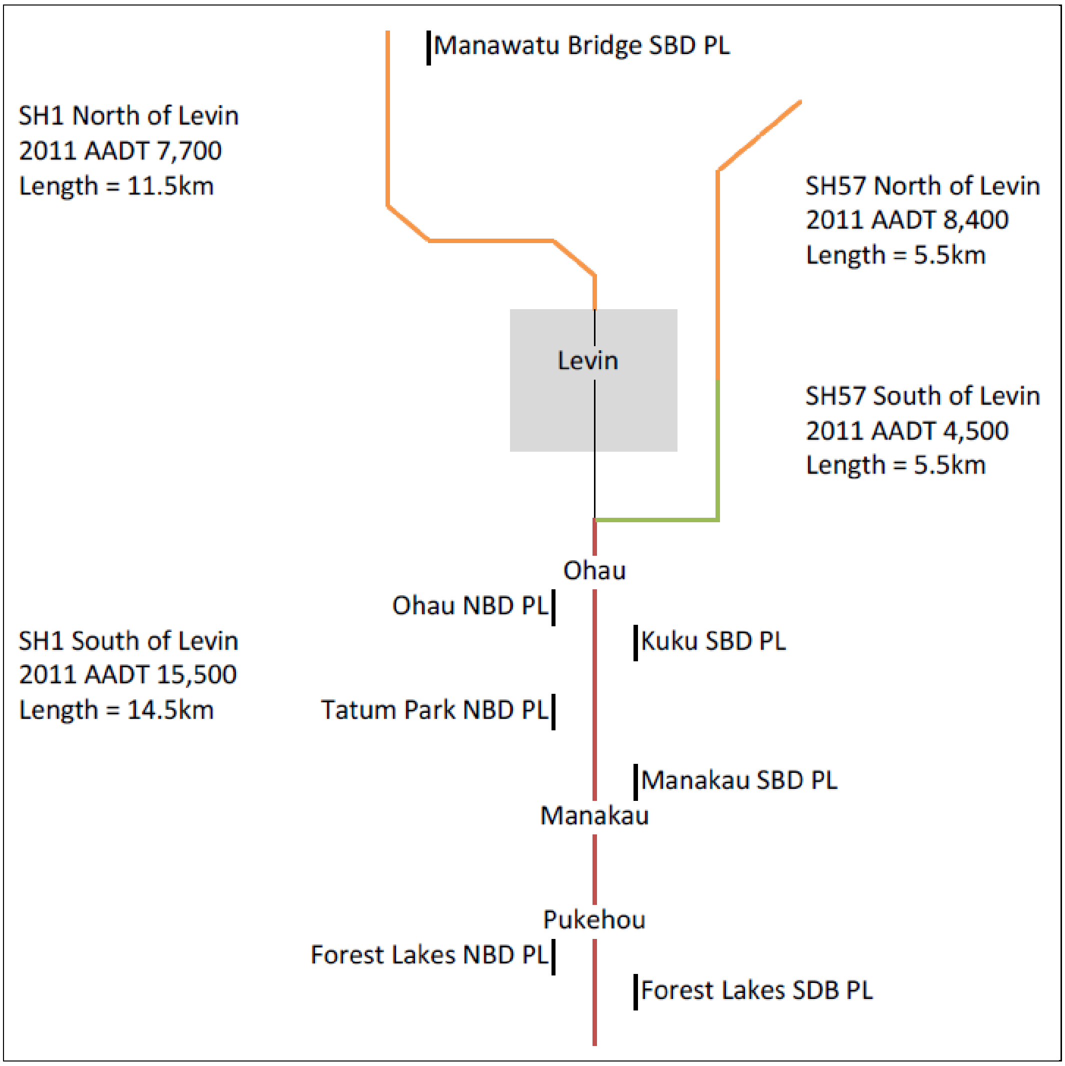

Figure 5-1: Existing Passing Lanes Schematic

Table 5-1: Existing Passing Lanes

Name	Length	Distance from previous passing opportunity	Distance to next passing opportunity
SH1 Northbound Passing Lanes			
Forest Lakes	970 m	2.4 km from Ōtaki 2.6 km from PP2O 4 lanes	5.6 km to Tatum Park PL
Tatum Park	520 m	5.6 km from Forest Lakes PL	2.4 km to Ohau PL
Ohau	640 m	2.4 km from Tatum Park PL	4.0 km to Levin
None from Levin to Foxton (15.6km)			
SH1 Southbound Passing Lanes			
Manawatu Bridge	750 m	4.1 km from Foxton	10.4 km to Levin
Kuku	400 m	5.5 km from Levin	3.4 km to Manakau PL
Manakau	620 m	3.4 km from Kuku PL	4.6 km to Forest Lakes PL
Forest Lakes	1000 m	4.6 km from Forest Lakes PL	1.0 km to Ōtaki 0.9 km to PP2O 4 lanes
SH57 Northbound Passing Lane			
Potts Hill	1030 m	11.1 km from SH1 5.6 km from Queen Street	6.2 km to Shannon
SH57 Southbound Passing Lane			
Potts Hill	600 m	2.6 km from Shannon	15.0 km to SH1 9.4 km to Queen Street

5.2 Crash History

Passing lanes prevent overtaking and head on crashes for the length of the passing lane as well as up to 5-10 km downstream and also upstream, as drivers anticipate a passing lane and do not perform risky manoeuvres (however this value has not been quantified).

As passing lanes have a wider area of affect than their direct area, crashes on state highways within 5 km of the study area have been included.

Table 5-2: Rural Head-On and Overtaking Crashes 2007-2011 between Otaki, Foxton and Shannon

Year	Fatal	Serious	Minor	Non-Injury	Total	DSI
2007	1	4	3	4	**12**	15
2008	-	1	5	8	**14**	2
2009	3	2	3	5	**13**	9
2010	-	3	3	9	**15**	3
2011	-	1	4	2	**7**	1
Total	**4**	**11**	**18**	**28**	**61**	**30**

Head-on and overtaking crashes typically have a high DSI rate per injury crash as they involve multiple vehicles and high impact speeds are involved. Within the study area there are 0.91 deaths and serious injuries per injury crash. Providing additional passing lanes and preventing overtaking in other locations could dramatically reduce the number of deaths and serious injuries within the study area.

5.3 Strategy

5.3.1 Long Term Strategy

Figure 5-2 below shows the long term passing lane strategy for the lengths of SH1 and SH57 within the study area. As the traffic volumes increase over 10,000 vpd overtaking outside of passing lanes becomes less viable, and so in 2041 only the section of SH57 between Queen Street East and SH1 does not require passing lanes. In summary the long term strategy is:

SH1: Ōtaki to SH1/SH57 split:	Four Lanes
SH1: SH57 to northern Levin urban boundary:	Urban or 80 km/h therefore no passing lanes
Remainder:	Passing lanes at 5 km nominal intervals

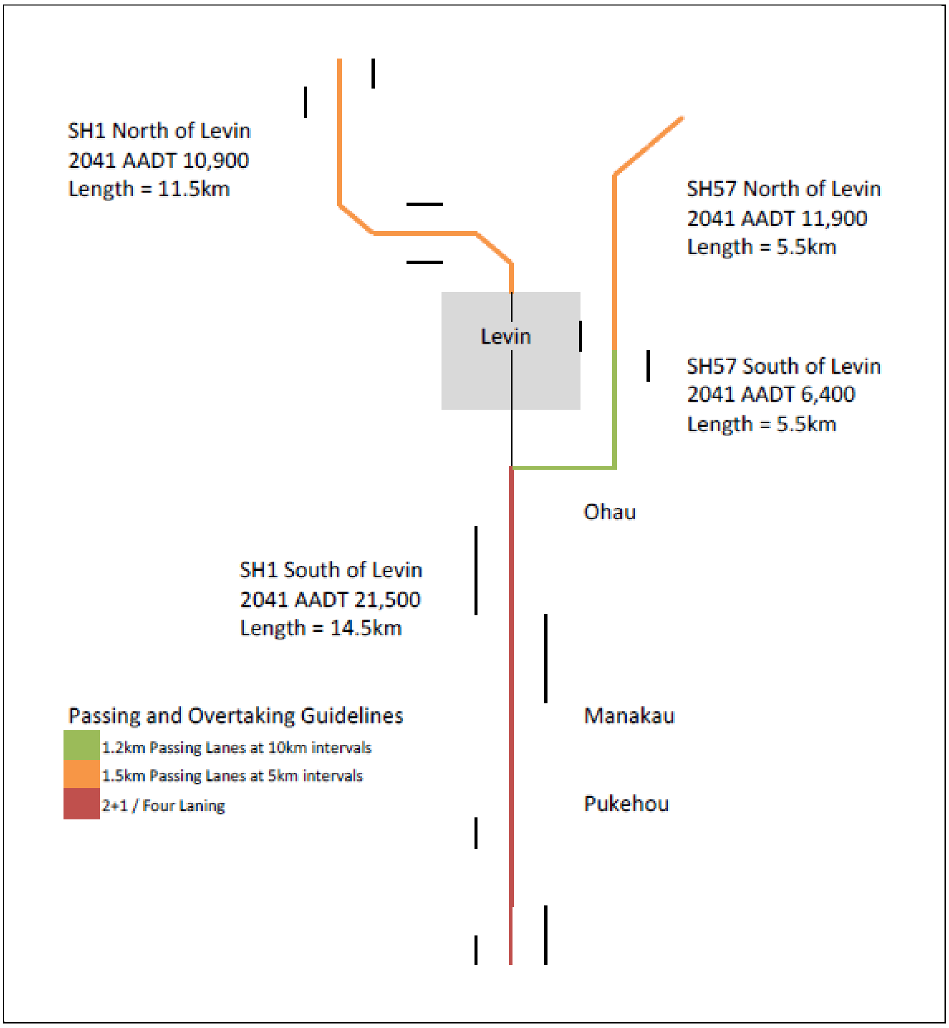

Figure 5-2: Long Term Strategy and proposed Short Term Passing Lanes

5.3.2 Short Term Strategy

5.3.2.1 SH1: Ōtaki to SH57 (15.4 km)

All the existing passing lanes in this section north of Forest Lakes are too short and may be affected by the package of short term projects. Accordingly, it is considered that it is best to provide new passing opportunities in conjunction with the projects that are being investigated. The most appropriate of these is the Manakau and Ohau Bridges PFR (Report No. 3), which can be provided as either 2+1 or 4-laning. If this was constructed as a 2+1 with the northbound 2 laning at the north and the southbound two laning at the south, for northbound travellers this would result in a gap of around 9km between PP2O and the passing lane and another 3 km between the passing lane and SH57. Accordingly, the Forest Lakes northbound passing lane could be retained. For southbound traffic it would result in 5 km between SH57 and the passing lane and another 7 km between the passing lane and PP2O. This is considered appropriate since from this point will be continuous four laning to Wellington. In summary the short term strategy for this section is as follows:

- Retain Forest Lakes northbound passing lane
- Provide passing lanes / 2+1 / four lanes on Manakau to Ohau project
- Remove Forest Lakes southbound passing lane
- Remove existing Ohau and Manakau passing lanes

5.3.2.2 SH1: Levin to Manawatu River (11.7 km)

This length requires two passing lanes in each direction, especially as there are no northbound passing opportunities until north of Foxton. In summary, the short term strategy for this section is as follows:

- New northbound passing lane just north of Levin
- New northbound passing lane north of Waitarere Beach Road
- Retain southbound passing lane south of Manawatu River
- New southbound passing lane south of Waitarere Beach Road

5.3.2.3 SH57 (11 km)

When considering the section south of Queen Street East, the traffic volumes only require passing lanes every 10 km. However when taken in conjunction with the section north of Queen Street East where the volumes are greater, another passing opportunity is required between SH1 and the existing opportunities north of Potts Hill. It is considered that the most appropriate place for these facilities is on the departures from the Queen Street East intersection which is being considered in PFR No. 10: In summary the short term strategy for this section is as follows:

- New northbound passing lane north of Queen Street East
- New southbound passing lane south of Queen Street East (requires closing or restricting movements from Meadowvale Drive)

5.4 Alternatives and Options Considered

There are seven proposed passing lanes which form the short term strategy. The discussion below focusses on these passing lanes. It is noted that the lengths of these passing lanes are only indicative and do not consider any constraints which would reduce their length.

On SH57, north and southbound passing lanes, approximately 1.5 km in length, could tie into the Queen Street East roundabout considered in Report No. 10. If both projects proceed, these passing lanes will not require a start taper.

North and southbound passing lanes are proposed either side of Waitarere Beach Road (Report No. 8) which could tie into the left and right turn acceleration lanes on SH1.

A northbound passing lane is proposed immediately north of Levin on SH1, approximately 1.5 km in length. There are currently no northbound passing lanes within an approximate 16 km extent of this stretch of state highway.

North and southbound passing lanes between Ohau and Manakau (Bridges) on SH1 approximately 2 km in length, could potentially be configured as a lane reduction and gain in conjunction with the proposed SH1/SH57 split depending on its location. These passing lanes would replace the existing four passing lanes which are deficient in length. The configuration of these passing lanes could be either 2+1 or 4-laning, with the latter being the better fit.

5.5 Cost Estimates

Passing lane costs have been estimated using the estimated cost of the Sanson South Passing Lane in the NLTP. This project has a construction cost of approximately $850,000 (this excludes property costs, risk, and professional fees) and extends over 1.6 km. This gives a cost rate of $530,000 per kilometre on flat terrain. It is assumed that this project includes 100 m start taper, and 250 m of end taper which is included in the overall passing lane length and cost.

The Queen Street East and Waitarere Beach Road passing lanes are assumed not to require a start taper as they will begin exiting a roundabout or by adding a lane at an intersection merge.

Also it has been assumed that the costs of passing lanes in rolling terrain is 28% more than flat terrain which is the ratio between rolling and flat in the EEM.

Table 5-3: Estimated Passing Lane Construction Costs

Passing Lane Name	Length (+ Merge and Tapers)	Estimated Cost per km	Estimated Construction Cost (000's)
SH1 Bridges Nbd	2 km + 0.35 km	$530,000	$1,250
SH1 Bridges Sbd	2 km + 0.35 km	$530,000	$1,250
SH1 Levin North Nbd	1.5 km + 0.35 km	$680,000	$1,260
SH1 Waitarere Beach Sbd	1.5 km + 0.25 km	$680,000	$1,190
SH1 Waitarere Beach Nbd	1.5 km +0.25 km	$680,000	$1,190
SH57 Queen St Sbd	1.5 km +0.25 km	$530,000	$930
SH57 Queen St Nbd	1.5 km +0.25 km	$530,000	$930
Total Package	**11.5 km + 2.05 km**		**$8,000**

These costs exclude any economies of scale from construction of concurrent passing lane projects at the same time, e.g. if Queen Street East, Waitarere Beach, and Manakau to Ohau Bridges passing lanes were combined into one contract..

Estimates have not been built up from itemised costs and do not include risk.

5.6 Economic Assessment

The economic benefits of the proposed passing lanes were calculated using the EEM Simplified Procedures (software version 5.3.4), with an 8% discount rate over 30 years and update factors from September 2011.

Table 5-4: Passing Lane Benefits (Simplified Procedures)

Passing Lane Name	TT and VOC Benefits (000's)	Driver Frustration Benefit (000's)	Adjustment Factor	Accident Savings Benefit (000's)	Total Estimated Benefits (000's)	Estimated BCR
SH1 Bridges Nbd	$1,870	$174	1.46	$1,200	$3,920	3.1
SH1 Bridges Sbd	$1,820	$172	1.46	$1,200	$3,860	3.1
SH1 Levin North Nbd	$2,050	$176	1.30	$1,160	$3,820	3.0
SH1 Waitarere Beach Sbd	$1,650	$150	1.3	$960	$3,150	2.6
SH1 Waitarere Beach Nbd	$1,670	$150	1.33	$960	$3,180	2.7
SH57 Queen St Sbd	$479	$58.5	1.31	$411	$1,110	1.2
SH57 Queen St Nbd	$1,350	$144	1.27	$637	$2,580	2.8
Total	**$10,200**	**$1,020**	**-**	**$6,530**	**$21,600**	**2.7**

5.7 Other Aspects

The EEM simplified procedures method considers a limited range of crash benefits. If a wire rope median barrier is included within these projects, there will be additional benefits to head-on crashes, run-off-road crashes, and crossing and turning crashes.

5.8 Conclusions and Recommendations

The above passing lanes appear viable. However the lengths are required to be evaluated fully in the Scheme Assessment phase as they do not consider constraints, property costs or risks.

6 Side Friction

Accessways and side roads impose 'friction' to the free flow of vehicles along the highway due to delays caused from vehicles turning left and right to and from the highway.

6.1 Existing Situation

The state highways within the study area were progressively declared Limited Access Road (LAR) between the early 1970s and early 1990s. Prior to the declaration of LAR status these highways had few controls on the location and number of accessways. Many land owners hold title on multiple adjacent land parcels, and many of these land parcels have historic multiple legal crossing places, which are infrequently or dis- used, but have not been revoked and physically closed.

6.2 Crash History

Rural accessway crashes are considered to have one of the 920 series of crash factor codes 'entering or leaving lane use' and occurring in speed limits greater than or equal to 70 km/h. This does not encompass all accessway related crashes which may not have been appropriately coded as occurring at entering or leaving land use.

Table 6-1: Rural Accessway Crashes 2007-2011 within Study Area

Year	Fatal	Serious	Minor	Non-Injury	Total	DSI
2007	-	1	4	4	**9**	1
2008	-	-	1	5	**6**	-
2009	-	-	3	1	**4**	-
2010	-	-	-	6	**6**	-
2011	-	-	-	4	**4**	-
Total	**-**	**1**	**8**	**20**	**29**	**1**

Over the last five years, there have been 29 reported crashes coded as entering or leaving land use (920 series); including one serious injury crash, eight minor injury crashes, and 20 non-injury crashes. The serious injury crash resulted in one serious injury and occurred when a car hit a school bus turning right across the highway from the left hand shoulder, the car driver was seriously injured.

Typically around 30% of injury crashes result in death or serious injury, however, these accessway crashes have a much lower rate, and this is likely to be due to lower speeds of vehicles involved.

Additionally there has been one reported non-injury crash in 2012 at the time of the CAS query.

Of these 30 crashes including the partial history of 2012, seven occurred within 50 m of another accessway crash at three locations. Detailed investigations revealed that two of the three locations were at fruit and vegetable stores north of Levin and at Manakau ('Garden of York' & 'Brown Acres'), the other multiple crash location was at Tatum Park; however, only one crash could be confirmed as a turning movement into this accessway and recent improvements have installed a right turn bay.

6.3 Strategy

The strategy for side friction is:

- To physically close existing second and third accessways to land parcels that are infrequently used or disused.
- Where practical relocate access to sections with alternative side road frontage.
- Where multiple land parcels have the same ownership, encourage the owners to use a single accessway in a good location to all land where practicable, and physically close the other accessways.
- Physically close unauthorised accessways.
- Improve the standard of those accessways to be retained in conjunction with seal widening and where appropriate in line with NZTA's Planning Policy Manual.

The table below outlines where accessways are not in accordance with the strategy, categorised by the section of state highway (particularly where another PFR is being considered on that section).

Table 6-2: Summary of Accessways

Area	Land Parcels with 1 Accessway	Land Parcels with 2+ Accessways[2]	Relocatable to Side Road	Unformed/ Physically Closed Accessway	Unauthorised Accessway[3]	Total
PFR1	21	-	-	6	-	**27**
PFR2	23	3	-	6	-	**32**
PFR3	90	15	-	17	-	**122**
PFR5	67	11	4	20	2	**104**
PFR8	35	10	1	12	1	**40**
PFR10	3	-	1	5	-	**9**
Other SH1 South of Levin	35	3	6	11	-	**55**
Other SH1 North of Levin	57	16	12	20	-	**105**
Other SH57	76	34	14	28	5	**157**
Total	**407**	**93**	**38**	**125**	**8**	**671**

The following PFRs have been excluded from Table 6-2. PFR4 (Ohau) has been excluded as it is solely within the PFR5 area, PFR6 has been excluded as it is deals with the heavy vehicle bypass, PFR7 has been excluded as it is solely within urban Levin and not on Limited Access Roads, and PFR 9 (Whirokino Trestle) has been excluded as it is outside the study area.

6.4 Conclusions and Recommendations

Within other improvement projects, be they realignment, guard railing, passing lane or other, investigations should be carried out into physically closing individual accessways with the land owners to leave each legal property with a single accessway, ideally with only one formed accessway for all adjacent properties with the same land owner with the location of unformed accessways specified in a safe location in the event of future land sales.

For those accessways which are not within other PFRs investigate improvements to those accessways which need to be retained and those which can be closed.

7 Side Roads

Intersections with priority controlled side roads provide significant hazards and inefficiencies by introducing conflict points. Crashes at and in close proximity (less than 50 m) resulted in over 40% of the deaths and serious injuries within the study area over the five year period (2007-2011) and includes all the urban deaths and serious injuries[4] and over 37% of the rural deaths and serious injuries.

[2] This includes multiple adjacent properties with the same land ownership, land ownership which may be different from land users.
[3] Additional unidentified Unauthorised accessways may exist within the study area
[4] It should be noted that the generally close spacing of intersections in urban areas means that most crashes occur within 50 m of an intersection.

7.1 Existing Situation

There are currently 46 rural intersection locations on the existing alignment of SH1 and SH57 within the study area, which are either T or cross road junctions. Their distribution is outlined in Table 7-1 below. Table 7-2 and Table 7-3 list all side roads within the study area for SH1 and SH57, their location, which PFR they are also within, the side of the highway the side road is on (D=decreasing, I=increasing), their form, AADT, and what facilities are currently provided.

The side roads within the study have a variety of features with various functions, traffic volumes and types.

Table 7-1: Summary of Rural Side Road Junctions

Area	T-Junction	Cross Road	Staggered T	Total
SH1 South of Levin	24	1	-	**25**
SH1 North of Levin	8	3	-	**11**
SH57	6	4	1	**11**
Total	**38**	**8**	**1**	**47**

Table 7-2: State Highway 1 Intersections

Side Road	Location	PFR#	Side	Form	AADT	Characteristics
Taylors Road	995/3.30	1	D	T-Junction	250	Giveway (G), No Exit (NE), Flag Light (FL)
Lawsons Road	995/2.60	1	D	T-Junction	~20	Uncontrolled (U), NE, Passing Lane (PL),
Forest Lakes Road	995/1.255	1	D	T-Junction	180	Stop (S), NE, FL, PL
Atkins Road	985/10.92	-	D	T-Junction	-	G, NE, Low Sight Distance (SD)
South Manakau Road	985/10.40	-	I	T-Junction	300	S, FL
Gleesons Road	985/9.27	-	D	T-Junction	120	G, NE, Lit (L), Right Turn Bay (RTB)
Honi Taipua Street	985/8.98	2	I	T-Junction	-	S, FL
Mokena Kohere Street	985/8.49	2	I	T-Junction	580	G, L, RTB
Waikawa Beach Road	985/8.12	2	D	T-Junction	1,000	G, NE, L, PL, RTB
North Manakau Road	985/7.48	3	I	T-Junction	300	G, NE, FL, RTB
Whakahoro Road	985/7.06	3	D	T-Junction	150	S, NE, FL, SD
Honeysuckle Lane"	985/6.74	3	I	T-Junction	-	G, NE, SD
Kuku East Road	985/4.29	3	I	T-Junction	250	G, NE, FL
Kuku Beach Road	985/4.16	3	D	T-Junction	670	G, NE, L, RTB
Parakawau Road[5]	985/2.64	5	I	T-Junction	150	S, NE, PL
Bishops Road	985/2.28	4&5	I	T-Junction	60	S, PL
Muhunoa East Road	985/1.84	4&5	I	Cross	650	S, L, RTB, Left Turn Deceleration Lane (LTDL)

[5] Parikawa Road SH1 South of Levin

Side Road	Location	PFR#	Side	Form	AADT	Characteristics
Muhunoa West Road	985/1.84	4&5	D	Cross	700[6]	S, L, RTB, LTDL
Victoria Terrace	985//1.61	4&5	D	T-Junction	250	S, SD
Marseden Terrace	985/1.40	4&5	D	T-Junction	-	S, SD, NE – road closed
Vista Road	985/1.10	4&5	D	T-Junction	80	S, NE, FL
McLeavy Road	985/0.73	5	I	T-Junction	390	G, FL
Buller Road	985/0.46	5	D	T-Junction	710	G, L, RTB, 80 km/h
Kimberley Road	985/0.0	5	I	T-Junction	4,480	G, L, RTB, LTDL, Left Turn Acceleration Lane (LTAL), 80 km/h
Boulton Road	967/16.69		D	T-Junction	110	G, FL, RTB, 80 km/h
Cambridge Street South[7]	967/15.76		I	T-Junction	2,440	U, L, RTB, LTDL, LTAL, Right Turn Out Banned, 80 km/h
Roslyn Road[8]	967/12.13		I	T-Junction	1,000	U, L, Left In Left Out, 70 km/h
Lindsay Road	967/11.40		D	T-Junction	290	G
Avenue North Road (Sth)	967/10.81		D	T-Junction	280	G, SD
Heatherlea East Road (Est)	967/10.09		I	T-Junction	390	G, FL, RTB, SD
Koputaroa Road (Sth)	967/9.95		I	Cross	820	S, FL, RTB, SD
Avenue North Road (Nth)	967/9.95		D	Cross	100	S, FL, SD
Te Whanga Road	967/8.09		I	Cross	240	S, NE, FL, RTB, LTDL
Kawiu Road (Nth)	967/8.09		D	Cross	860	S, FL, RTB, LTDL
Clay Road	967/7.47		I	T-Junction	-	S, NE
Paeroa Road	967/6.25	8	D	T-Junction	70	S, NE
Waitarere Beach Road	967/5.89	8	D	T-Junction	1,740	G, NE, L, RTB, LTDL, LTAL
Koputaroa Road (Nth)	967/3.31		I	T-Junction	280	S, FL, RTB
Oturoa Road	967/1.50		D	T-Junction	140	G, NE, FL
Whirokino Road	954/12.89	9	I	Cross	100	S, SD
Matakarapa Road	954/12.89	9	D	Cross	60	S, NE – access under Whirokino Trestle, SD

[6] 50 m West of Jervois Terrace 2007
[7] Tararua Rail Crossing, 11 m west of Cambridge Street South
[8] Within 70 km/h zone at the northern end of Levin

Table 7-3: State Highway 57 Intersections

Side Road	Location	PFR#	Side	Form	AADT	Facilities Present
Tui Glen Drive	0/0.84	5	I	T-Junction	100	S, FL
Arapaepae Road	0/2.08	5	D	Cross	810	S, L
Kimberley Road	0/2.08	5	D	Cross	410	S, L
Tararua Road (Wst)	0/3.45		I	Cross	1,010	S, FL
Tararua Road (Est)	0/3.45		D	Cross	910	S, FL
Meadowvale Drive	0/5.06	10	I	T-Junction	1,040	S, L, RTB
Queen Street East (Wst)	0/5.57	10	I	Cross	4,190	S, L, RTB, LTDL, LTAL
Queen Street East (Est)	0/5.57	10	D	Cross	1,680	S, L, RTB, LTDL
Waihou Road (Sth)	0/6.90		D	T-Junction	80	S
Roslyn Road	0/7.63		I	T-Junction[9]	1,660	S, FL, RTB
Waihou Road (Nth)	0/7.63		D	Cross	90	G, FL
McDonald Road	0/8.13		D	T-Junction	120	S, NE
Heatherlea East Road (Wst)	0/9.05		I	T-Junction	320	S, FL
Wallace Road	0/9.88		D	Staggered T	290	G, NE, L, RTB, Right Turn Acceleration Lane (RTAL)
Tavistock Road	0/9.94		I	Staggered T	420	G, L, RTB, RTAL
Potts Road	0/11.11		D	T-Junction	310	G, NE, FL, RTB

7.2 Crash History

Rural crashes that occurred within 50 m of an intersection are shown in Table 7-4 below. These crashes are not exclusively crossing and turning movement types. Intersection form and line marking can have an effect on the numbers of non-crossing and turning crashes such as rear-end, pedestrian, head on, and loss of control crash movements.

[9] The Roslyn Road left in left out (LILO) facilities on SH1 is ineffective as road users often ignore or perform dangerous U-turn manoeuvres in the vicinity of the intersection. This is common with LILO style intersections.

Table 7-4: Rural Crashes within 50 m of an Intersection 2007-2011

Year	Fatal	Serious	Minor	Non-Injury	Total	DSI
2007	1	3	3	21	**28**	8
2008	-	2	11	13	**26**	2
2009	-	5	7	12	**24**	6
2010	-	1	5	7	**13**	2
2011	-	2	3	11	**16**	2
Total	**1**	**13**	**29**	**64**	**107**	**20**

7.3 Strategy

Side roads with similar function, traffic volumes and types should all have consistent layout and features. A consistent approach to the inclusion of right turn bays, lighting, and left turning lanes, and other engineering features is required. Some rural side roads have the potential for closure as there are other parallel routes with better features to provide access to local farms, shops, and industry.

Within the ten proposed individual projects in the PFR stages, consistency works can be carried out easily. Wire rope barrier projects provide an excellent opportunity for left in left out works to be effectively implemented when combined with appropriately spaced safe turn around facilities to allow side road and property access which has been restricted.

7.4 Conclusions and Recommendations

All side roads within the study area should be investigated for their traffic types, volumes, and function they provide. This will allow for a consistent treatment of form and control, layout, and facilities to be applied across the study area. Wherever viable, side roads should be closed with access provided through alternate local roads.

8 Vertical Profile

The purpose of this part of the report is to determine the sight distance (both safe stopping and overtaking), comfort and aesthetics provided by the existing highways in regards to vertical ‘crest’ and ‘sag’ curves and propose and prioritise projects to address the current deficiencies.

8.1 Existing Situation

The existing highways have numerous vertical curves that are deficient in terms of sight distance, headlight sight distance, comfort or aesthetics when measured against guidance provided by Austroads and when evaluated using High Speed Data video footage.

Frequently the vertical curves are near to other features and the combination of features often results in a reduction in sight distance or poor aesthetics. Examples of combinations are; crest curves near side roads or crest curves near to sag curves, in both of these cases hazards on the other side of the crest can be hidden from an approaching driver’s field of vision.

Some very short vertical curves are present that appear to present no safety hazard but are likely to have a detrimental effect on the comfort of road users.

For the purposes of this report only vertical curves that present a potential safety hazard or where overtaking opportunities are compromised have been considered.

8.2 Crash History

Vertical curves contribute to crashes through limiting sight distance, seen in overtaking, crossing and turning, hit object and loss of control crashes as well as other crash types. Table 8-1 shows all crashes and deaths and serious injuries occurring within 50 m of a vertical curve for which there is proposed treatment. See Table 8-3, Table 8-4, and Table 8-5 for treatment proposals.

Table 8-1: All Crashes 2007-2011 within 50 m of a proposed vertical curve improvement

Year	Fatal	Serious	Minor	Non-Injury	Total	DSI
North of Levin	-	1	5	5	**11**	1
South of Levin	2	3	14	18	**37**	6
SH57	-	3	4	10	**17**	4
Total	**2**	**7**	**23**	**33**	**65**	**11**

The 50 m proximity was used as crash records within CAS can be inaccurate on the exact location of the crash, this also included crashes which occurred beyond the vertical curve, but had the curve contributing to the outcome. It should be noted that these listed crashes could be unrelated to the vertical curves.

Both of the two fatal crashes occurred on within the three vertical curves associated with the Manakau Rail Overbridge.

8.3 Strategy

The Austroads Guide to Road Design, Part 3: Geometric Design 2010 was used to determine requirements for vertical geometry. This guide provides tables of K values (change in grade over curve length) for vertical geometry. Tables 8.6 (desirable K values for comfort and aesthetics), 8.7 (minimum K values for safe stopping) and 8.8 (K values for safe overtaking) were used to determine requirements for crest curves while Figure 8.7 was used to determine requirements for sag curves. In most cases driver reaction time used to calculate safe distances (and therefore safe geometry) is 2.5 seconds; however in some cases, such as in areas with design speeds below 100km/h the Austroads tables use a reaction time of 2.0 seconds, these are shown in italics in Table 8.2 below.

Table 8-2: K Values used to determine vertical geometry requirements

Design Speed (km/h)	Desirable (crest)	Minimum (crest)	Overtaking (crest)	Sag
100 km/h	333 - 500	150 - 160	190	84 - 51
80 km/h	100 - 133	*45 - 22*	60	28
60 km/h	50 - 62	*17 - 9*	-	16

Once the requirements for geometry were set the RAMM geometry was analysed to identify deficient vertical curves. This analysis included checking the effects of nearby features, including other vertical curves.

8.4 Alternatives and Options Considered

Deficient vertical curves were ranked as being deficient against desirable criteria, minimum criteria and also deficient due to combination with nearby features. In some cases curves that are not deficient individually become deficient due to their proximity to another vertical curve or other feature. The curves identified for further investigation are those that present the greatest safety risk and in some cases these curves could potentially be improved to allow safe overtaking opportunities. Curves that are covered by specific studies such as railway overbridges have a note identifying them as such. In the case of large structures being required the reconstruction cost has not been calculated as these are all being addressed within other PFRs. Site specific studies will include assessment of vertical geometry along with other considerations to ensure overall improvement.

8.5 Cost Estimates

Cost estimates are based on a $1,500/m rate of reconstruction. This rate has been derived from comparison of rates for similar work and projects. The rate does not take into account site specific conditions, including whether or not curves are adjacent and resultant potential cost savings in those cases. Costs are rough order accuracy and do not include risk. This results in a total project value of $5.52M.

Table 8-3: SH1 North of Levin Vertical Curve Location and Details

Curve Midpoint	Location Description	Curve Type	Curve Length (m)	K Value	Reconstruction Cost (000's)
SH1 RP967/0.885	800m South of Manawatu River Bridge (vertical curve assessment start location)	Crest	130	45	$195
SH1 RP967/4.910	1km north of Waitarere Beach Road (may be included within Waitarere Beach Road PFR)	Crest	20	67	$30
SH1 RP967/7.290	250m north of Clay Road	Crest	140	70	$210
SH1 RP967/8.420	Clay Road to Koputoroa Road/ Avenue Road intersection	Crest	80	22	$120
SH1 RP967/8.740	Clay Road to Koputoroa Road/ Avenue Road intersection	Sag	40	11	$60
SH1 RP967/8.825	Clay Road to Koputoroa Road/ Avenue Road intersection	Crest	70	26	$105
SH1 RP967/9.035	Clay Road to Koputoroa Road/ Avenue Road intersection	Crest	110	14	$165
SH1 RP967/9.300	Clay Road to Koputoroa Road/ Avenue Road intersection	Sag	160	30	$240
SH1 RP967/9.565	Clay Road to Koputoroa Road/ Avenue Road intersection	Crest	70	23	$105
SH1 RP967/11.390	Lindsay Road	Crest	140	67	$210
SH1 RP967/11.695	300m South of Lindsay Road	Sag	250	42	$375
				Total	**$1,815**

Table 8-4: SH1 South of Levin Vertical Curve Location and Details

Curve Midpoint	Location Description	Curve Type	Curve Length (m)	K Value	Reconstruction Cost (000's)
SH1 RP985/0.865	Between Vista Road and McLeavey Road	Crest	290	104	$435
SH1 RP985/1.110	100m south of Vista Road	Sag	160	73	$240
SH1 RP985/1.355	400m south of Vista Road	Crest	230	64	$345
SH1 RP985/3.150	In Manakau to Ohau PFR	Sag	80	32	N/A
SH1 RP985/3.285	In Manakau to Ohau PFR	Crest	190	28	N/A
SH1 RP985/3.540	In Manakau to Ohau PFR	Sag	100	50	N/A
SH1 RP985/6.165	Tatum Park accessway (In Manakau to Ohau PFR)	Crest	90	25	$135
SH1 RP985/6.290	Tatum Park accessway (In Manakau to Ohau PFR)	Sag	60	29	$90
SH1 RP985/6.690	In Manakau to Ohau PFR	Sag	160	36	N/A
SH1 RP985/6.860	In Manakau to Ohau PFR	Crest	180	18	N/A
SH1 RP985/7.020	In Manakau to Ohau PFR	Sag	140	24	N/A
SH1 RP995/0.920	900m south of Pukehou rail overbridge (in Forest Lakes PFR)	Crest	360	80	$540
SH1 RP995/2.330	1.1km south of Forest Lakes Road (in Forest Lakes PFR)	Crest	380	75	$570
				Total	**$2,355**

Table 8-5: SH57 Vertical Curve Location and Details

Curve Midpoint	Location Description	Curve Type	Curve Length (m)	K Value	Reconstruction Cost (000's)
SH57 RP0/2.125	Kimberley Road/ Arapaepae Road Intersection	Crest	50	36	$75.0
SH57 RP0/6.835	50m south of Waihou Road south	Sag	190	73	$285
SH57 RP0/7.065	200m north of Waihou Road south	Crest	190	44	$285
SH57 RP0/7.375	250m south of Roslyn Road	Crest	70	33	$105
SH57 RP0/8.245	100m north of McDonald Road	Crest	110	48	$165
SH57 RP0/9.025	Just south of Heatherlea East Road	Crest	290	74	$435
				Total	**$1,350**

8.6 Conclusions and Recommendations

Analysis of the existing vertical geometry against criteria based on Austroads geometric safety guidance and potential provision for overtaking has identified deficient vertical curves on SH1 and SH57. These vertical curves have been identified by location and description in Table 8-3, Table 8-4, and Table 8-5 above, including cost estimates to reconstruct the roads to a higher standard. It is recommended that each of these curves (not already contained within a separate study) be investigated further for feasibility of improvement.

9 Walking and Cycling

The purpose of this part of the report is determine the level of walking and cycling facilities provided on the state highway in rural and urban areas. There are currently some facilities in urban and peri-urban Levin, but relatively few facilities outside of this area in rural environments.

9.1 Existing Situation

9.1.1 Rural Situation

Currently there is little provision for separated walking and cycling facilities in the rural areas outside of Levin. The few exceptions are the pedestrian underpass in Ohau connecting the community with the school in a 100 km/h zone and the footpath on the western side of the Kuku Stream Bridge. There are numerous narrow bridges without appropriate pedestrian or cyclist space with no alternative routes within and neighbouring the study area. Sealed shoulder widths are outlined earlier in Table 4-1.

It should be noted that there is a separated pedestrian/cycle facility on SH1 north of the study area running parallel to the Whirokino Trestle (which is subject to a separate PFR), as it is a narrow bridge. However also it should be noted that there is no equivalent facility to cross the neighbouring Manawatu Bridge forcing potential pedestrians and cyclists onto 200 m of live traffic lanes with little or no sealed shoulder width.

There is currently significant variation in shoulder width which impedes cycling on the highway. While some segments of highway have appropriate width for cyclists, they are frequently isolated and so prove ineffective.

The pedestrian demand in rural areas is restricted to the small settlements of Manakau and Ohau and at locations where groups of residential properties exist. Pedestrian movements also occur across the highway at rural selling places (e.g. fruit and vegetable outlets).

9.1.2 Urban Levin

Urban and peri-urban Levin extends from the 100 - 80 km/h speed limit change south of Kimberley Road (SH57) to the 70 - 100 km/h speed limit change north of Roslyn Road. Current facilities include:

Walking

- Continuous footpath on the western side of SH1 from Kimberley Road (SH57) to Roslyn Road.
- Continuous footpath on the eastern side of SH1 from Kawiu Road to approximately Hokio Beach Road.

Cycling

- Northbound cycle lane transforms from roadside parking at Hokio Beach Road, this transforms into a hatched shoulder area beside marked car parks at South Lane. This marking continues to Durham Street.
- Southbound, painted hatched area between traffic lanes and parking space turns into a cycle lane at just north of South Street; this cycle lane then leaves the carriageway and continues beside the footpath parallel with the highway until Hokio Beach Road.

Median/Crossing facilities

- For most of the highway between Tyne Street and Kimberley Road (SH57) there is a painted flush median which is punctuated with right turn bays and other facilities.
- Traffic island directly south of York Street.
- Zebra pedestrian crossing between York Street and Essex Street. This crossing has kerb build outs and a narrow island separating the lanes.
- Pedestrian signals on all arms of the Queen Street East and Bath Street Intersections.
- From Durham Street to South Lane there is a narrow raised median with occasional gaps for right turn movements.

9.2 Crash History

Table 9-1: Pedestrian and Cyclist Crashes 2007-2011

Year	Fatal	Serious	Minor	Non-Injury	Total	DSI
2007	-	1	3	-	**4**	1
2008	-	1	-	1	**2**	2
2009	1	1	5	1	**8**	2
2010	-	1	4	-	**5**	1
2011	-	-	1	-	**1**	-
Total	**1**	**4**	**13**	**2**	**20**	**6**

Five cyclist crashes occurred in the five year period, none of which resulted in death or serious injury. Four of these crashes resulted in injury, which were evenly split between rural and urban state highway lengths. The cyclists injured were in their 30s, 40s and 50s.

87% of pedestrian injury crashes occurred within the urban areas of Levin. However these crashes only accounted for 50% of the deaths and serious injuries. 60% of the pedestrians injured within Levin were within their 70s or older, and all of the deaths and serious injuries were within this age bracket. Four of these elderly pedestrian crashes occurred at the Bath Street and Queen Street East signalised crossings, two crashes occurred between Bath and Queen Street East, while the final two occurred in close proximity to Exeter and Devon Streets.

The serious injury crashes in the Exeter and Devon Street area were; a pedestrian crossing the road being hit within the current painted flush median on the left side, and a pedestrian stepping out from behind a parked vehicle being hit from a vehicle on the left side.

Three of the pedestrian crashes between Bath Street and Queen Street East occurred when pedestrians standing on or crossing to the flush median were hit by vehicles wanting to turn right at either Bath Street or Queen Street East while there was a queue of stopped through traffic.

There were two rural pedestrian crashes within the study area in the last five years, both occurring on SH57. These two crashes resulted in three deaths or serious injuries. The high severity of rural crashes is due to the vulnerability to pedestrians at higher speeds. Of these crashes; one occurred in snow or hail weather conditions, and the other involved an intoxicated pedestrian wearing black at night.

9.3 Strategy

9.3.1 New Zealand Cycle Trail

The New Zealand Cycle Trail (NZCT) network has produced a potential long term vision for a national cycle network. This network connects major population centres with the “Great Rides”, existing cycle routes, and proposed routes as well as key public transport connections such as ferries and rail. There are no proposed or existing routes on the west coast of the lower North Island.

Standards for NZCT for rural on-road routes with traffic volumes over 8,000 vpd include a sealed shoulder width greater than 1.5 m. Traffic volumes between 5,000 and 8,000 vpd require sealed shoulder widths greater than 1.0 m. Rural roads with over 18,000 vpd are not considered suitable for on-road NZCT cycling routes.

Over the next 30 years with traffic growth of 1.4%, the section of state highway south of the SH1/57 split is expected to exceed the NZCT 18,000 vpd on-road maximum. The rural section north from SH1/57 split to Levin is expected to exceed this NZCT limit in approximately 40 years. The long term requirements and strategy for cyclists will need to guide what short and medium term solutions are provided for the existing demand and expected long term trends south of Levin to avoid redundancy. Other rural links are not expected to exceed the NZCT maximum within the foreseeable future.

9.3.2 Roads of National Significance

Roads of National Significance standards are to either provide new off-road walking and cycle facilities, or exclude them from the proposed routes where there are alternatives routes. Due to the strategy of upgrading the existing route, it is not considered appropriate to provide separate walking and cycling facilities in the short term, therefore on road provision needs to be considered. In the longer term, the creation of a four-lane expressway would necessitate further consideration of the pedestrian and walking strategy.

9.3.3 Long Term Ōtaki to Levin

The long term strategy for pedestrians and cyclist between Ōtaki and north of Levin is to:

- Bypass or remove all the pinch points for pedestrians and cyclists on the state highways
- Provide adequate sealed shoulders for cyclists on the state highways including on bridges
- Provide cycle facilities at all ramp crossings and intersections, especially roundabouts.
- Work with Horowhenua District Council to provide appropriate crossing facilities of the state highway where there are significant severance effects.
- Provide an off-highway walking and cycling facility south of the SH1/57 split.
- Tie into urban cycle network in Levin.

9.3.4 Short Term Ōtaki to Levin

The short term strategy for pedestrians and cyclists between Ōtaki and north of Levin is to:

- Provide adequate sealed shoulders for cyclists within all site specific projects which proceed
- Provide cyclist facilities at all ramp crossings and intersections, especially roundabouts within all site specific projects which proceed
- Ensure adequate pedestrian crossing facilities in Levin, Ohau and Manakau
- Ensure adequate shoulders for cyclists are provided when developing short term projects which are route consistency focused
- Ensure any existing facilities are not adversely affected by the implementation of any of the short term strategy projects.

9.4 Alternatives and Options Considered

The majority of the measures required to achieve the short term strategy will be considered as part of site specific projects.

The only additional project that needs consideration is an additional crossing facility between Queen Street East and the York-Essex Zebra crossing in Levin, which has been investigated due to the high severity crashes in this location.

9.5 Pedestrian Crossing Warrant

A brief pedestrian crossing survey was carried out in the vicinity of Exeter and Devon Streets where the two serious injury pedestrian crashes were located. This survey was to get an understanding of pedestrian desire lines and crossing numbers in this area.

From this survey it was identified that the pedestrian desire line crossing SH1 is dominant at the end of Exeter Street which has a supermarket and liquor store and is opposite a discount butchery. Devon Street contains the local RSA and has businesses which are more industrial in nature.

Applying the crossing rate across an entire hour, and using this as the peak hour flow, and the traffic volumes on SH1 throughout the day, this site meets the 1988 Zebra Crossing Warrant as well as the Signalised Crossing Warrant. Due to the nature of the crash history, a crossing refuge island was not considered to be an acceptable level of pedestrian facilities. A more detailed analysis of vehicle and pedestrian crossing delays is still required to determine if a Zebra or Signalised Crossing is the optimum solution.

9.6 Conclusions and Recommendations

A more detailed survey and assessment of pedestrian movements at the Exeter Street Intersection to determine the best form of pedestrian crossing form and accommodating right turn movements to and from Exeter Street is recommended.

10 Conclusions

This report examines the feasibility of undertaking various area-wide safety and efficiency improvements on the sections of State Highway 1 and State Highway 57 through the Ōtaki to north of Levin study area. These improvements focus on roadside treatments (including sealed shoulder widening and barrier protection), passing lanes, rural accessways, rural intersections (layout, form and features), and walking and cycling facilities.

The contents of this report should be considered alongside the other project feasibility reports and the four laning report to determine the best package of improvements to progress as the first stage in the long term strategy.

Cost estimates and economics detailed within this report are rough order estimates and need further development before being considered with any confidence.