ŌTAKI TO NORTH OF LEVIN PFRS

Report No. 5: SH1 / SH57 Intersection & Arapaepae Curve Project Feasibility Report

Prepared for NZ Transport Agency

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QUALITY STATEMENT

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Executive Summary

This Project Feasibility Report (PFR) is one of a number of reports being undertaken to determine the package of improvements that should be implemented in the short to medium term 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 main purpose of this report is to determine the feasibility of a number of options for improving the connection between State Highway 1 and State Highway 57, south of Levin.

A variety of options were considered, with a total of four main options (with three having variations) taken forward to more detailed assessment, with four options economically evaluated and estimated to give indicative BCRs and rough order costs. A cost estimate is provided for each of these for options together with an economic assessment and associated Benefit-Cost Ratio.

The options considered ranged from improving the intersection at SH1/SH57 at-grade to full grade separation and a new greenfields link to SH57 which bypasses Ohau settlement and links with the options that have been developed for PFR Report No. 3 (Manakau to Ohau Bridges).

A summary of the options taken through to economic analysis is shown below.

Table 1-1: Option Summary

Option Description	Capital Costs	NPV Benefits	Benefit Cost Ratio
Option 5-1a – Grade separated SH1/57	$32.4M	$65.1M	**2.3**
Option 5-2 – SH1/57 Roundabout	$15.5M	$12.8M	**1.0**
Option 5-3a – Bifurcation North of Ohau	$46.8M	$74.9M	**1.9**
Option 5-4a – Bifurcation South of Ohau	$49.9M	$87.2M	**2.0**

Option 5-1a has the greatest BCR and therefore purely in economic terms is favourable. Incremental analysis favours either Option 5-1a or 5-4a.

Whilst the roundabout solution (Option 5-2) does have a BCR that demonstrates poor economic efficiency, the capital cost is significantly below the other 3 options and it would be advisable for further work to ascertain its viability based on more detailed information and analysis.

Option 5-3a exhibits a relatively similar capital cost to Option 4a but delivers less benefits and therefore should be omitted from further assessment (noting there are variations of Option 5-1a and 4a which can also be considered), while a half diamond interchange may also warrant consideration.

It is therefore recommended that Options 5-1a, 5-2 and 5-4a are considered further at the Scheme Stage when more information is available on the adjoining sections and the long term 4-laning solution.

NZ Transport Agency

Report 5: SH1/57 & Arapaepae Curve

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1 Introduction and Background

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 Project Feasibility Report (PFR) 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 improvements to aid road safety and traffic flow at and near the intersection of State Highway 1 and State Highway 57 south of Levin.

The geographical extent of this project includes the intersection of SH1/SH57, the intersection of SH57 Arapaepae Road with SH57 Kimberley Road, as well as the 2.1 km midblock section of Kimberley Road that runs between both intersections. In addition, the study area also extends south to the Ohau River as the options considered consist of alternative alignments for SH57 to avoid the two right angle turns at the aforementioned intersections. It is noted that Manakau to Ohau Bridges (PFR No. 3), the Ohau Settlement (PFR No. 4), and the heavy Vehicle Bypass (PFR No. 6) either adjoin, or are within, this PFR and therefore the results and conclusions of the three PFRs are intrinsically linked.

The outcome of this PFR will be considered alongside the outcomes of the other PFRs and used to determine the best package of works to progress as the first stage of the long term strategy.

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 (i.e. edge treatment, passing lanes, walking and cycling, side friction etc; Report No. 11) and on Four Lane Alignments (Report No. 12).

3 Description of Problem

3.1 Ōtaki to North of Levin

State Highway 1 and State Highway 57 through the study area have a number of deficiencies, resulting in a poor crash history and a number of locations where the free flow of vehicles is restricted by the tight physical characteristics of the highway.

State Highway 1 currently follows the historic route established in the late 19th and early 20th centuries. As a consequence it is constrained by a now substandard alignment, towns and settlements, narrow curved bridges and significant side friction caused by local roads, commercial frontages and property accesses for the entire stretch.

3.2 State Highway 1 / State Highway 57 & Arapaepae Curve

The section of SH1 south of Levin to just north of the Ohau River has had a high number of crashes in recent years. Of particular concern are the side-on crashes due to the associated low survivability at speeds above 50 km/h[1]. A critical aspect of this area is the link from SH1 to Arapaepae Road. This comprises a T intersection with SH1, followed closely by a level crossing of the Main Trunk Railway Line and, 2.1 km further along SH57, a 90 degree corner at the intersection of Kimberley and Arapaepae Roads (both SH57).

Key safety and geometric deficiencies for the SH1 / SH57 intersection and the Arapaepae curve, determined through site inspections and previous reports, are presented below.

3.2.1 SH1 / SH57 Intersection

- Priority controlled 'T' intersection layout – in high speed (100 km/h) environment.
- Significant volumes of conflicting traffic movements, specifically the right turn movement from SH1 into SH57.
- Close proximity of railway line to SH1 road alignment and intersections.
- Constrained left turn facilities for traffic turning from SH57 onto SH1.
- No kerbed median (lack of channelization).
- Narrow carriageway – the right turn lane is below the desirable 3.5 m width. Substandard right turn bay.
- Substandard shoulder widths – shoulders are generally below the 1.5 m NZTA link criterion and the desirable RoNS guidelines of 2.5 m, which is concern for loss of control crashes as well as for cyclists.
- Poor crash history.

3.2.2 SH57 – Arapaepae Road / Kimberley Road Intersection

- 4-way priority intersection with unconventional layout.
- SH57 travels through a 90 degree change in direction with minimal curve radius < 20 m.
- Substandard shoulder widths.
- Unconventional / non-standard physical median provision.
- Poor crash history.

The above deficiencies are considered to have contributed to the poor safety record at both intersections and cause traffic delays. It is understood drivers use the local network to avoid the SH1/57 intersection.

[1] High Risk Rural Roads Guide (HRRRG), NZTA, September 2011

4 Site Description

The project area consists primarily of two key intersections. These are the SH1/SH57 intersection south of Levin (RP 985/0.00) and the SH57 Kimberley Road intersection with Arapaepae Road (RP 0/2.05), However, this PFR also considers a number of bypass options to connect SH57 with SH1, avoiding the existing SH1 / SH57 priority intersection, and hence covers as far south as just north of the Ohau River.

SH1 is a two lane undivided highway with approximately 3.5 m lane widths and varying shoulder width (approximately 0.5 m to 2.5 m). There are a number of local road intersections (described below).

SH57 Kimberley Road is a two lane undivided highway with approximately 3.5 m lane widths and varying shoulder width and a berm in places. There are a number of private vehicle driveways, accessed directly from the State Highway and two local road intersections. At the intersection with Arapaepae Road there is a short section (around 5 m) of kerbed central median of approximately 200 mm width and 50 mm height.

The section of SH57 Arapaepae Road considered in the study area is also a two lane undivided highway with approximately 3.5 m lane width and varying width shoulder and a berm in places. At the intersection with Kimberley Road there is a short section (around 5 m) of kerbed central median of approximately 200 mm width and 50 mm height.

The study area consists of a mix of residential, retail and commercial property with a combination of direct property access and side road access to both State Highways. Commercial land uses include agriculture, horticulture and grape cultivation / processing (winery).

Figure 4-1 below shows the study location.

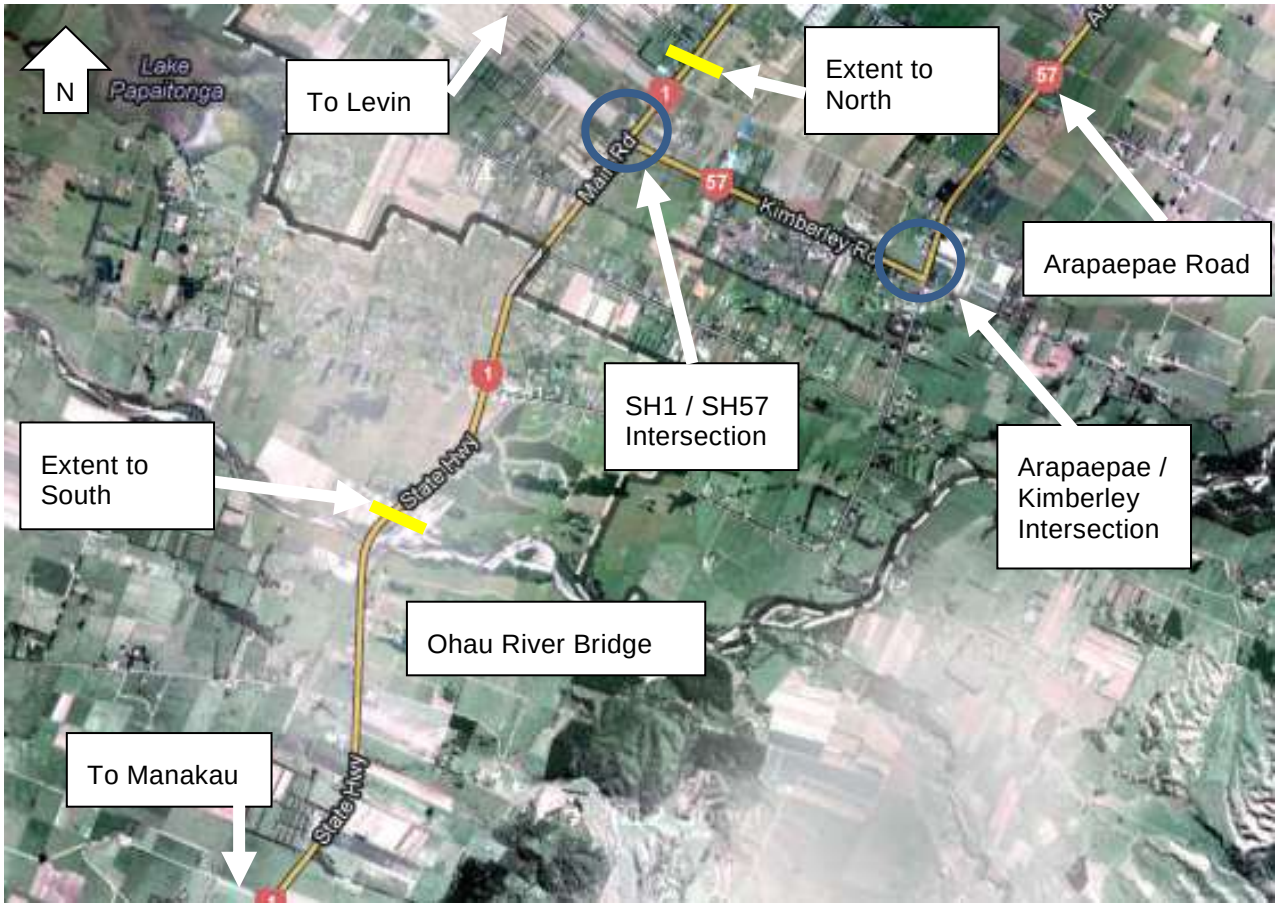


Figure 4-1: Study Area Location Map

There are a number of side roads that intersect the state highways along the study length, which has been defined as the area between Ohau River in the south and the SH57 intersection of Kimberley Road and Arapaepae Road in the north.

For SH1, the side roads are (from north to south):

- Buller Road (RP 985/0.45),
- Mcleavey Road (RP 985/0.70),
- Vista Road (RP 985/0.99),
- Marsden Terrace (RP 985/1.41),
- Victoria Terrace (RP 985/1.62),
- Muhunoa West Road / Muhunoa East Road (RP 985/1.84),
- Bishops Road (RP 985/2.28),
- Parakawau Road (RP 985/2.63),

For the length of SH57 within the study area, the side roads are (west to east):

- Tui Glen Drive (RP 0/0.51 & RP0/0.83)
- Kimberley Road / Arapaepae Road intersection (RP 0/2.03)

Another feature along the route is a northbound passing lane on SH1 from RP 985/2.89 to RP 985/2.16.

The North Island Main Trunk (NIMT) rail line runs predominantly parallel to SH1, to the east of the existing alignment. The rail line crosses SH57 close to its intersection with SH1, with an offset of approximately 30 m from the centreline of SH1.

5 Traffic Statistics

The Annual Average Daily Traffic (AADT) flow at the NZTA telemetry count site at Ohau (Count Site ID: 01N00988) was 14,600 vehicles per day (vpd), 2011, with the proportion of Heavy Commercial Vehicles (HCVs) at 10%.

The traffic growth rate at the count site is calculated to be 1.3%, using data from 1992 to 2011. Volumes typically increased from 1992 to 2005; however since then volumes have remained generally stable.

AADT for SH1 north of SH1/57 intersection and south of Levin was 11,500 vpd, 2011, with 9% HCV.

AADT at the NZTA Kimberley Road count site (RP000/1.8) was 4,500 vpd, 2011, with 11% HCV.

It is therefore clear that there are approximately 1,500 HCVs using SH1 and 500 HCVs using SH57 daily, which suggests about one third using SH57 and two thirds travelling though Levin. Anecdotal information suggests some HCVs use Queen Street East and SH1 in order to avoid the SH1/57 intersection though this is has not been quantified (hence an improved intersection would attract these drivers back to the highway route).

The Ōtaki to north of Levin SATURN base network model outputs[2] showing intersection Level of Service (LoS) for 2011 and 2041 for the intersection of SH1 / SH57 are outlined in Table 5-1 below:

[2] See Otaki to north of Levin Scoping Report

Table 5-1: Saturn Base 2011/2041 Network Modelling Results

Year	Intersection LoS
2011 AM	B
2011 IP	B
2011 PM	B
2041 AM	B
2041 IP	B
2041 PM	D

Further traffic information can be found in Appendix B.

6 Crash History

6.1 Crash Data

A review of NZTA's CAS database over the five-year period from January 2007 to December 2011 revealed a total of 79 crashes within the study area, which comprises the section of SH1 immediately north of the Ohau River Bridge to the intersection of SH1/SH57 (to 700 m north of SH1), Kimberley Road (between SH1 and the intersection with Arapaepae Road) & SH57 Kimberley / Arapaepae (using a 250 m intersection radius).

The project area has been assessed using both the High Risk Intersection Guide[3] (HRIG) and the High Risk Rural Roads Guide[4] (HRRRG). For the assessment of the two key intersections using HRIG, it is acknowledged that the HRIG states an intersection crash is any crash occurring within a 50 m radius of the centre of an intersection. However, given the high speed, rural environment, the analysis has used the industry standard of 250 m radius from the centre of an intersection for assessment purposes. This could be refined during the scheme stage as required.

It should also be noted that there has been a recent speed limit change in close proximity to the SH1/57 intersection, reducing the posted limit down from 100 km/h to 80 km/h on SH1 from Levin to south of the SH1/57 intersection. Whilst this is clearly road safety and community concern related, this speed reduction does penalise travel time and vehicle operating costs.

The following tables provide a summary of the CAS output data for the study area:

Table 6-1: Annual Distribution of Crashes

Year	Fatal	Serious	Minor	Non-Injury	Total	DSi*
2007	-	1	3	13	**17**	2
2008	-	-	4	13	**17**	-
2009	-	-	2	14	**16**	-
2010	-	1	6	8	**15**	1
2011	-	3	3	8	**14**	3
Total	**-**	**5**	**18**	**56**	**79**	**6**

* Death and serious injury casualties

[3] High Risk Intersection Guide (HRIG), NZTA, March 2012 (Draft)
[4] High Risk Rural Roads Guide (HRRRG), NZTA, September 2011

Table 6-2: CAS Crash Type

Crash Type	Number of Reported Crashes	Percentage of Reported Crashes
Head on	1	1%
Hit Object	5	6%
Lost Control Off Road	24	30%
Lost Control On Road	1	1%
Miscellaneous	3	4%
Overtaking	7	9%
Rear End, Crossing	3	4%
Rear End, Queuing	8	10%
Rear End, Slow Vehicle	8	10%
Crossing, Direct	1	1%
Crossing, Turning	18	23%
Total	**79**	**100%**

The following two tables outline the crash types at the two intersections being considered.

Table 6-3: HRIG Injury Crash Types – SH1 / SH57 Intersection

Crash Type	Number of Reported Injury Crashes	Percentage of Reported Injury Crashes
Lost Control (C Type)	2	22%
Turning v Same (G Type)	1	11%
Crossing veh turning (J Type)	1	11%
Right turn against (L Type)	4	44%
Miscellaneous (Q Type)	1	11%
Total	**9**	**100%**

Table 6-4: HRIG Injury Crash Types –SH57 Kimberley Road / Arapaepae Road Intersection

Crash Type	Number of Reported Injury Crashes	Percentage of Reported Injury Crashes
Crossing no turn (H Type)	1	50%
Cornering (D Type)	1	50%
Total	**2**	**100%**

Whilst the primary objective of this PFR is to consider the connection between SH1 and SH57, given the study area is wider than just the intersections in isolation, it is considered appropriate to also use the HRRRG to further analyse the study area:

Table 6-5: HRRRG[5] Crash Type

Crash Type	Number of Reported Crashes	DSi	Percentage of Reported Crashes
Head on	1	-	1%
Run off Road	25	2	32%
Intersection Crashes	22	3	28%
Other	31	1	39%
Total	**79**	**6**	**100%**

The crashes classified as 'Other' above include eight crashes resulting in a rear end collision from queued traffic, together with a further four rear end collisions due to slow moving vehicles. Three crashes were non-vehicular obstructions and a further three resulted from lane changing.

Table 6-6: Crash Causation Factors of Reported Injury Crashes

Causation	Number of Reported Injury Crash Causation Factors
Alcohol	5
Too fast	7
Failed giveway/stop	17
Overtaking	3
Incorrect lane/position	17
Poor handling	7
Poor observation	32
Poor judgement	18
Fatigue	5
Vehicle factors	8
Road factors	12
Weather	3
Other	9

Table 6-7: Environmental Factors

	Wet	Dry		Night	Day		Weekend (Fri 6:00PM to Monday 5:59AM)	Weekday
No.	25	54		15	64		27	52
%	32	68		19	81		34	66

Of the crashes occurring within the 6.2 km length of the study area:

- None were fatal, five were serious, eighteen were minor and fifty-six were non-injury.
- 25 (32%) involved run-off road movements resulting in two serious and seven minor injury crashes (2 DSi).
- 22 (28%) involved intersection related crashes, resulting in two serous and five minor injury crashes.

[5] High Risk Rural Roads Guide (HRRRG), NZTA, September 2011

- Throughout the five year analysis period of the project length, there was only one head-on crash and this did not result in personal injury.
- There are four (9%) loss of control turning right crashes located at the intersection of SH57 Arapaepae Road turning right into SH57 Kimberley Road. This resulted in one minor and three non-injury crashes.
- There are three (7%) loss of control on straight crashes at the intersection of SH1 / SH57 with vehicles travelling northbound on SH1. This resulted in one minor and two non-injury crashes.
- There is a predominance of 'right turn against' manoeuvres located at the intersection of SH1 right turning into SH57, with 9 (11%) of all crashes in the study area of this type at this location. This resulted in one serious and three minor injury crashes (1 DSI)
- A further two crashes occurred with crossing movements with a right turn out of SH57 to SH1 heading north and colliding with a vehicle heading south on SH1, resulting in one minor injury crash.
- Poor judgement or poor observation was a causal factor in 63% of crashes, with the other main causation factors being incorrect lane positioning and failure to giveway.
- 31 (39%) crashes involved objects being struck; e.g. traffic sign, fence, ditch, tree etc.

It is noted that there has been a recent spike in serious crashes within the study area (during 2010 and 2011). Whilst these four crashes could represent random events, it is feasible that this is evidence of the highway not coping with recent traffic patterns.

6.2 Crash Risk

This section of SH1 and SH57 has been analysed using two methods. The High Risk Intersection Guide (HRIG) has been utilised to calculate crash risk at this intersections of SH1/57 and SH57 Kimberley Road / Arapaepae Road. In addition, as the project area is wider than these two intersections, the High-Risk Rural Roads Guide (HRRRG) has also been used to determine crash risk for the wider corridor. This includes the length of SH1 from Ohau River (north side of existing river bridge) to the SH57 intersection, the length of Kimberley Road between SH1 and Arapaepae Road and the approaches to the Arapaepae Road / Kimberley Road intersection, a total length of 6.2 km.

HRIG identifies that crash risk can be defined in two specific ways:

- Collective Risk, also known as Crash Density, is measured as the number of fatal and serious (F&S) crashes per intersection in a crash period
- Personal risk or crash rate is measured in terms of the number of F&S crashes per 100 million vehicles using an intersection

6.2.1 Crash Risk: SH1/57 Intersection

In terms of collective crash risk for the intersection of SH1/SH57, there are two methods of calculation

- Reported F&S Crashes: Over the five year assessment period: there have been two F&S crashes
- Estimated F&S Crashes: The second method involves the estimation of F&S crashes that have occurred at an intersection using all injury crashes that have occurred during the crash period. This method takes into account the crash movement type, intersection form and control, and collision speed on crash severity outcomes. The estimated collective crash risk is calculated at 2.68 F&S crashes for a 5 year period. This is presented in the table below:

Table 6-8: Estimation of F&S Collective Risk Using Severity Index SH1 / SH57 Intersection

Crash Type	Number of Reported Injury Crashes	Adjusted F&S crashes / All injury crashes[6]	Estimated Number of F&S Injury Crashes
Lost Control	2	0.25	0.50
Turning v Same	1	0.24	0.24
Crossing veh turning	1	0.28	0.28
Right turn against	4	0.29	1.16
Miscellaneous	1	0.50	0.50
Total	**9**		**2.68**

Therefore, according to HRIG[7] and using either method of calculation, this intersection is considered high risk when quantifying collective risk (as there is greater than 1.6 F&S crashes).

When considering personal risk, a calculation is performed which considers the major and minor road traffic volumes to determine the product of flow to standardise the number of potential conflicts that could occur at an intersection. The SH1 / SH57 intersection is calculated as having a personal risk value of 110. According to HRIG[8], this results in a medium-high personal risk level.

The Level of Safety Service (LoSS)[9] for this intersection is category V[10] which demonstrates poor safety performance on a five point scale.

6.2.2 Crash Risk: SH57 Kimberley Road / Arapaepae Road Intersection

For Collective Crash Risk:

- Reported F&S Crashes: Over the 5 year assessment period, there has been 1 F&S crash
- Estimated F&S Crashes: The estimated collective crash risk is calculated at 0.58 F&S crashes for a 5 year period. This is presented is the table below:

Table 6-9: Estimation of F&S Collective Risk Using Severity Index SH57 Kimberley Road / Arapaepae Road Intersection

Crash Type	Number of Reported Injury Crashes	Adjusted F&S crashes / All injury crashes	Estimated Number of F&S Injury Crashes
Crossing no turn (H	1	0.24	0.24
Cornering (D Type)	1	0.34	0.34
Total	**2**		**0.58**

Therefore, according to HRIG, using F&S injury the prediction method the intersection is low-medium.

The SH1 / SH57 intersection is calculated as having a personal risk value of 38 (with the assumed traffic flows on both the Kimberley Road and Arapaepae being equal and using the Kimberley count data). According to HRIG, this results in a low personal risk level.

This intersection is determined to be LoSS category 'I' (one) which represents a good safety performance level relative to similar intersections.

[6] HRIG, Table 8.10
[7] HRIG, Table 4-1
[8] HRIG, Table 4-2
[9] Level of Safety Service, as defined by HRIG, is a method of categorising the safety performance of an intersection compared to other intersections of that type.
[10] LoSS categories range from I (one) to V (five) where intersections classified as LoSS I have a safety performance that is better than other intersections of that type, in the same speed environment and with similar traffic flows. For intersections of Category V, the converse is true.

6.2.3 HRRRG Crash Risk (Full Study Area)

In addition to considering the SH1/SH57 intersection, the project area corridor of SH1 / SH57 was also analysed according to the High-Risk Rural Roads Guide (HRRRG) which identifies that crash risk can be generally defined in two ways:

- Actual Crash Risk; which is based on crashes reported in the last 5 years. This is separated into collective risk, which is also known as crash density, and personal risk, which is also known as crash rate.
- Predicted Crash Risk; which is based on KiwiRAP road protection score (RPS) and the KiwiRAP star rating.

In terms of crash risk this 6.2 km section of SH1 and SH57 has:

- A collective risk of 0.16 high-severity (fatal and serious) crashes per km per year;
- A personal risk[11] of 3.02 high-severity crashes per 100 million vehicle km; and
- A KiwiRAP 2 star rating

Therefore, the collective risk is considered 'Medium-High' whilst the personal risk is 'Low' for this section of the State Highway network.

Further Crash Data can be found in Appendix C.

7 Alternatives and Options Considered

A number of improvement options have been considered for the SH1 / SH57 intersection and Arapaepae Curve. All options aim principally to improve safety and traffic flow between SH1 and SH57 and Kimberley Road and Arapaepae Road (SH57). A focus has been on improving the substandard geometry and removing or reducing conflict points.

The Do Minimum for this assessment is the continued maintenance and operation of the existing highway.

The seven options considered are outlined below:

Option 5-1a/b Grade Seperation – Grade separation of right turn movements to and from (Option 5-1a Only) SH57 at the SH1/57 priority T-junction, as well as improvements to SH57 through carriageway widening and curve realignments.

Option 5-2 Roundabout – Replace the existing priority T-junction at the intersection of SH1/57 with a Roundabout, as well as improvements to SH57 through carriageway widening and curve realignments.

Option 5-3a/b Bifurcation North of Ohau – Move the SH1/57 junction and alignment of SH57 south (but north of Ohau), including improvements to SH1 and SH57 through carriageway widening and curve alignment.

Option 5-4a/b Bifurcation South of Ohau – Move the SH1/57 junction and alignment of SH57 to south of Ohau, including improvements to SH1 and SH57 through carriageway widening and curve alignment.

All options have incorporated an improved cross-sectional road design together with due cognisance of the need to ensure four laning can be achieved with limited or no abortive works in the future.

7.1 Discarded Options

The options below have been considered and subsequently excluded from further investigation within this PFR. It is however fully accepted that these options could be revisited later if it is deemed that they warrant further consideration or would provide a more coherent solution to connect to adjacent improvement options.

[11] HRRRG personal risk has been calculated using the SH1 AADT, however it should be noted that part of the project length includes SH57 which has a much lower AADT.

7.1.1 Interchange at SH1/57

The provision of a full interchange at this location catering for all movements has been excluded on the basis that the roundabout solution (Option 5-2) creates sufficient capacity and does not induce unacceptable levels of delay. A full interchange at this location is also unwarranted given the current demand for certain turning movements is so low – for example the right turn out of SH57 Kimberley to head north on SH1 or the left turn from SH1 into SH57. Even in the 2041 horizon years these flows are predicted to remain fairly low. There would be negative effects on vehicle travel times with this option.

However, it is acknowledged that a full diamond interchange (or even half-diamond) could be introduced to provide for the connection between SH1/SH57. It should be noted that a full diamond would cater for all movements though would require significant land. A half-diamond may suffice in providing for a limited number of movements. This option may warrant further investigation at the scheme stage.

Nevertheless, as this location is likely to be the long term transition from four lanes down to two, a partial or grade separated solution appears to be more appropriate.

7.1.2 Signalisation of SH1/57

This option has been discounted on the basis of being out of context in a rural (and high-speed) environment. A signalised intersection here would be remote and unexpected for drivers on such a section of the state highway network, and would likely result in an increase in injury crashes and possibility severity.

7.1.3 Improve & Reclassify Tararua Road as SH57

This option has been discounted as it does not provide any additional benefits or features to the options tested for the existing SH1/SH57 intersection / connection. The use of Tararua Road is likely to simply migrate problems from the existing SH57 Kimberley Road route to another location. Additionally, relocating the SH1/57 intersection and part of SH57 route closer to Levin is not considered advisable as it may unnecessarily constrain future improvement opportunities. Finally, this has been removed from further consideration as this option is likely to incur significant cost increases beyond that of works to the existing SH57 Kimberley Road alignment, without realising any demonstrable additional benefits.

7.1.4 New Alignment from SH1/57 to Tararua Road/SH57

This option has been discounted because of the NZTA's preference to utilise as much existing highway as possible, provided a suitable option exists. Therefore, it is concluded that Options 5-1a, 5-1b & 5-2 consider in sufficient detail the improvement options that a new link would create, and do so maximising the usage of SH57 Kimberley Road.

7.1.5 Options splitting SH 57 south of Ohau River

This has been discarded on the basis of cost effectiveness. Splitting SH1 and SH57 south of Ohau River would result in two new river crossings rather than only one (for the north of the river solutions) as part of the initial capital outlay. Similar options are considered as Options 5-4a & 5-4b but with the split occurring north of the river thereby avoiding an unnecessary river bridge duplication.

However, it is critical to understand that this option does have a number of benefits that may warrant discussion and further investigation at the SAR stage. Benefits include; improved SH57 travel times, potential reduced river crossing width (and hence cost), significant reduction to the long term 4-laning extents (potentially up to 5km reduction in 4-laning of SH1). A key drawback of this option would be the need to finance two river crossings as part of the initial capital outlay (whereas for the other SH1/57 connection options, the second river crossing would require implementation later to facilitate the overall 4-laning solution).

7.2 Option 5-1a: Grade Separated turns from SH1 to SH57

Outline plans of this option are provided in Appendix D. For a typical cross section of the proposed highway, see Section 7.9.

This option consists of:

- Grade separated right from SH1 into SH57 (and left turn from SH57 to SH1), with restricted movements

- As above but with left turn at grade
- Improved curve radius between Kimberley Road and Arapaepae Road (475 m)
- Widening of Kimberley Road to 11 m (two 3.5 m lanes and two 2.0 m shoulders).

For this option, the corridor width required for the areas of grade separation will be dictated by the methods used to elevate the structures. A conceptual corridor width of 25 m has been assumed at this stage for the entire length. However, this will require further assessment and three dimensional conceptual design work, after a decision has been made on structural supporting materials and methods. At elevated sections the road reserve will be substantially wider if batters are used.

It is also noted that fully rigid barriers would be required on the overbridge to restrain an errant vehicle from potentially leaving the overbridge structure and descending to the state highway or rail alignment beneath. A rigid barrier system has been costed on the construction costs / economic evaluation.

The grade separation included in this option has been assumed to be provided for using structural concrete retaining walls in conjunction with MSE batter slopes, whilst 25 m offsets from the high point of any structures has been indicated on the drawings. An assessment of the most suitable / cost-effective method is required at the scheme stage and will most likely be a consideration of the additional land required for fill batter construction as opposed to greater cost for concrete retaining walls.

7.3 Option 5-1b: Grade Separated right turn only SH1 to SH57

Outline plans of this option are provided in Appendix D. For a typical cross section of the proposed highway, see Section 7.9.

This option is a variation of Option 5-1a with the grade separated left turn facility (over rail) from SH57 to SH1 at grade. Presently the left turn out does not have a significant crash history and an acceleration lane slip exists for left turning traffic prior to merging with southbound SH1 traffic. It is unlikely that any at grade solution could be significantly better than the current arrangement given the current geometry and close position of the rail line.

As that this option is simply a variant of Option 5-1a, no specific cost estimates or economics have been undertaken but it is reasonable to conclude that the figures produced for Option 5-1a will be similar (though significantly there is one less bridge structure in this option). Should this option be favourable, then it will be advisable for more detailed analysis to be undertaken at the Scheme Assessment stage.

7.4 Option 5-2: SH1 / SH57 Roundabout

Outline plans of this option are provided in Appendix D. For a typical cross section of the proposed highway, see Section 7.9.

This option consists of:

- A roundabout at the intersection of SH1 / SH57
- Relocation of the SH1 / SH57 intersection westwards to provide suitable separation to the rail line
- The realignment of SH1 on the south roundabout approach to provide an 1100m radius which supports future 4-laning.
- Extension of SH57 westwards by 200 m
- Widening of Kimberley Road to 11 m (two 3.5 m lanes and two 2.0 m shoulders)
- Improved radius between Kimberley Road and Arapaepae Road (475 m)

This option incorporates the typical cross section of two 3.5 m traffic lanes and two 2.0 m shoulders throughout, except for the approaches to, or exit from, the roundabout. Two approach and two circulatory lanes are proposed at the new roundabout, with the dual lane lengths derived from the intersection modelling and projected horizon year queue length requirements.

The roundabout is offset from the existing SH1/SH57 ‘T’ intersection to allow for sufficient queuing space on the SH57 approach to ensure that at the 2041 design year, vehicles are not queuing back over the rail.

Some consideration was given to whether this could be used as the first stage of a full grade separated interchange. However, due to the location of the railway line and other constraints this would not be easily achievable and would result in redundant construction.

In addition, a further sub-option was considered which retains a significantly greater amount of the existing SH1 but this results in a broken back curve alignment and reduced standards and would not be future proofed for any 4-laning solution, and was therefore discounted.

It would be advisable at the SAR stage to investigate the merit of a slip lane on SH1 for northbound traffic.

7.5 Option 5-3a: Bifurcation North of Ohau

Outline plans of this option are provided in Appendix D. For a typical cross section of the proposed highway, see Section 7.9.

This option consists of:

- Route bifurcation north of Ohau
- Widening of SH1 north of Ohau (two 3.5m lanes and two 2.0m shoulders)
- New SH57 link structure over current SH1 and rail alignment
- New curve radii (two 3.5 m lanes and two 2.0 m shoulders) with a single bridge and two ramp structures connecting SH57 to SH1 (grade separating the right turn from SH1 into SH57 and the left turn movement from SH57 to SH1).
- Improved radius between Kimberley Road and Arapaepae Road (475m)

With this option, a K value of 150 has been used for Safe Stopping Distance for the vertical (crest) curve profile for the grade separation. Whilst 300 is the desirable figure for safe passing, it is not envisaged that the grade separated structures would be suitable for passing and therefore 150 is considered reasonable. This reduces the overall length of the structure ramps and therefore the impact on the surrounding environment and anticipated cost (see Section 8 – a reduced K factor would further reduce costs – which should be assessed at the SAR stage).

For Option 5-3a, it is assumed that SH1 will remain at-grade, with the grade-separated ramps for SH57 merging & diverging from the SH1 traffic lanes. For the future 4-laning solution, the 4-laning of SH1 would transition back to two lanes at this point (with the lane gain becoming the SH57 on ramps and lane drop just beyond the off ramp prior to the overbridge). This option results in some route shortening for certain movements, which delivers associated journey time savings.

The grade separation included in this option has been assumed to be provided for using structural concrete retaining walls in conjunction with MSE batter slopes, whilst 25 m offsets from the high point of any structures has been indicated on the drawings. An assessment of the most suitable / cost effective method is required at the scheme stage and will most likely be a consideration of the additional land required for fill batter construction as opposed to greater cost for concrete retaining walls.

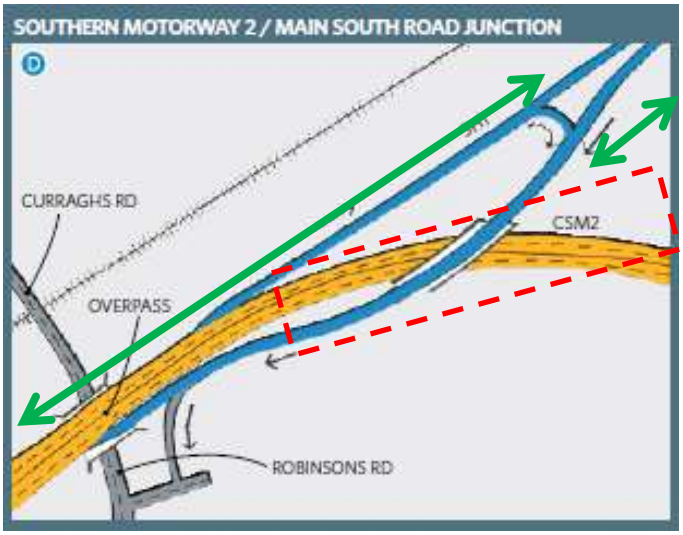
7.6 Option 5-3b: Bifurcation North of Ohau Alternative

Outline plans of this option are provided in Appendix D. For a typical cross section of the proposed highway, see Section 7.9.

This option is identical to Option 5-3a above except for the layout of the bifurcation structure when an alternative bridging structure is proposed and SH57 joins / leaves SH1 from the right. This option utilised a more unusual method of bifurcation where State Highway 1 runs around the outside of the SH57 structure. It is fully acknowledged that such a method is less common and less intuitive than Option 5-3a – however it could offer some benefits in terms of reduced bridging structure cost (as a single structure may be used for SH57 to span SH1 and the rail) as well as a smaller footprint.

An arrangement with some similarity is proposed on Christchurch Southern Motorway Phase 2, as per the following diagram (CSM2 represents SH57, and SH1 is shown as SH1):

SH1 would merge / diverge from the outside of SH57



SH57 joins SH1 as the central lanes (with SH1 merging and diverging to the side) - differs from this example as SH57 would be over SH1 to avoid rail

Figure 7-1: CSM2 Bifurcation Schematic Plan

As that this option is simply a variant of Option 5-3a, no specific cost estimates or economics have been undertaken but it is reasonable to conclude that the figures produced for Option 5-3a will be similar. Should this option be favourable, then it will be advisable for more detailed analysis to be undertaken at the Scheme Assessment stage.

7.7 Option 5-4a: Bifurcation South of Ohau

Outline plans of this option are provided in Appendix D. For a typical cross section of the proposed highway, see Section 7.9.

This option is predicated on the adjacent section PFR – Manakau to Ohau Bridges (Report No. 3) and assumes the alignment west of the railway is progressed. This option would require a new river crossing over the Ohau River west of the existing bridge. As the new bridge structure is included in the Manakau to Ohau cost estimate, it is omitted from this PFR, as are all benefits.

This option consists of:

- The realignment of SH1 north of Ohau River (two 3.5 m lanes and two 2.0 m shoulders).
- Bifurcation of the route to a proposed SH57 link north of the with structures over SH1 and the railway.
- A proposed 2-lane road to link into Arapaepae Road (two 3.5 m lanes and two 2.0 m shoulders), resulting in route shortening and journey time savings for SH57 traffic.
- No further improvements to SH1.

A vertical crest curve K value of 150 has been used in drafting this option to allow for safe stopping sight distance. This obviously has an effect on the size and of the overbridge structure (see Section 8 – a reduced K factor would further reduce costs – which should be assessed at the SAR stage).

The grade separation included in this option has been assumed to be provided for using structural concrete retaining walls in conjunction with MSE batter slopes, whilst 25 m offsets from the high point of any structures has been indicated on the drawings. An assessment of the most suitable / cost-effective method is required at the scheme stage and will most likely be a consideration of the additional land required for fill batter construction as opposed to greater cost for concrete retaining walls.

This option results in some route shortening for certain movements, which delivers associated journey time savings. A key benefit of this option is the bypassing of Ohau.

7.8 Option 5-4b: Bifurcation South of Ohau Alternative

Outline plans of this option are provided in Appendix D. For a typical cross section of the proposed highway, see Section 7.9.

Similar to Option 5-4a above, this option is predicated on the adjacent section PFR – Manakau to Ohau bridges option and proposed river crossing being provided east of the current SH1 road and rail bridges.

This option would require a new river crossing over the Ohau River west of the existing bridge. As the new bridge structure is included in the Manakau to Ohau cost estimate, it is omitted from this PFR.

This option consists of:

- The realignment of SH1 north-east of the current position and connecting into a proposed bridge structure across Ohau River (two 3.5 m lanes and two 2.0 m shoulders).
- Bifurcation of the route to a new SH57 link north of the river with the rest of the existing combined road and rail structure with SH1 elevated (as per PFR No. 3).
- New SH57 2-lane greenfield link to Arapaepae Road (two 3.5 m lanes and two 2.0 m shoulders).
- No further improvements to SH1.

A vertical crest curve K value of 150 has been used in drafting this option to allow for safe stopping sight distance (see Section 8 – a reduced K factor would further reduce costs – which should be assessed at the SAR stage).

As this option is simply a variant of Option 5-4a, no specific cost estimates or economics have been undertaken but it is reasonable to conclude that the figures produced for Option 5-4a will be similar. Should this option be favourable, then it will be advisable for more detailed analysis to be undertaken at the Scheme Assessment stage.

7.9 Other Aspects

All options have incorporated an improved cross-sectional road design together with due cognisance of the need to ensure RONS standards can be achieved with limited or no abortive works in future. For this PFR, a typical cross section of two 3.5 m lanes and two 2.0 m sealed shoulders, 0.5 m unsealed shoulders and 4.0 m swales has been assumed (resulting in a 20.0 m to 25.0 m road corridor width depending on terrain, cut/fill volumes and utility requirements). This is shown below:

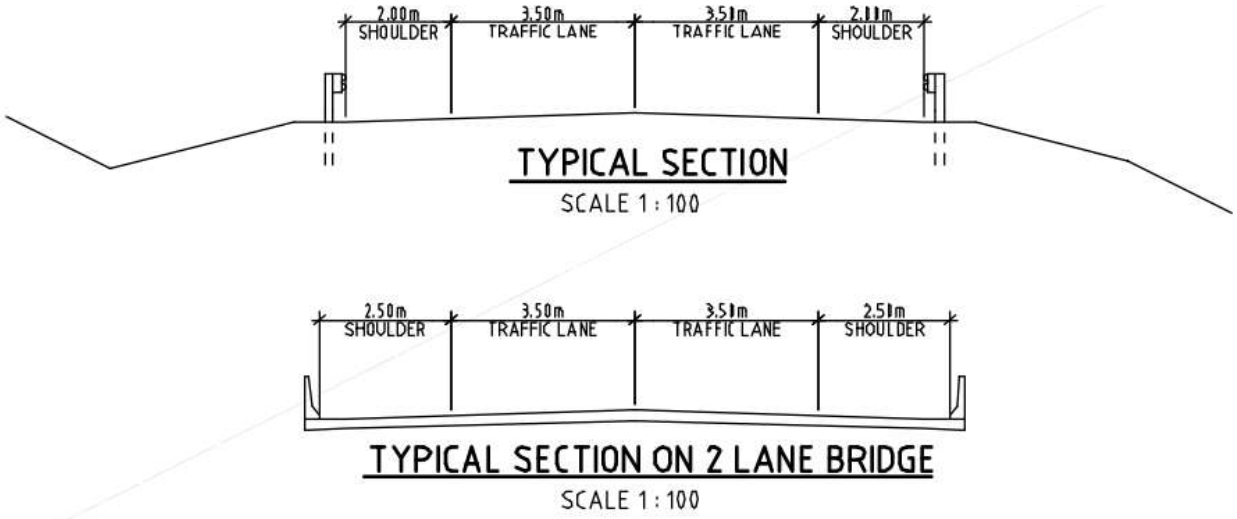


Figure 7-2: Typical Cross Section

It is also important to recognise that clearzones have not been incorporated into this PFR – the indicative corridor widths shown are purely to give some flexibility within the designation. Batter slopes could potentially be steepened to reduce earthworks and land requirement. Moreover, where the risk of runoff road crashes is high, edge protection (principally using wire rope barrier) is the preferred option (from both a safety and economic perspective). However, edge protection is not currently proposed throughout this project at this stage. Whilst there are a significant number of runoff road crashes within the project area, the improvements to road geometry will result in significant safety improvements.

Should it be deemed that edge protection is still required at critical locations, then it may be introduced - however it is not proposed as a corridor-wide treatment at this stage.

Additionally, to ensure consistency in comparison, all options have included an upgrade to SH1 between the Ohau River and the existing intersection with SH1/57 as per the typical cross-section above.

8 Design Statement

This project is at a feasibility stage, and therefore several assumptions have been made in the design.

The design assumptions include the following:

- The cost estimate has been based on the judgement of an engineer who has knowledge of the site.
- The cost estimate has been based on the assumption that the project can be built using proven technology.
- No adverse ground conditions are encountered (e.g. contaminated material).
- For the structures element, an initial assessment has been undertaken and draft sketches produced of a possible layout for each option, including MSE embankments and bridging members. A full structural assessment should be undertaken at scheme stage, particularly given the lack of topographical and geotechnical information.
- A vertical crest K value of 150 has been utilised to meet safe stopping sight distance requirements for 110 km/h design speed (2.5 s reaction time). A vertical sag curve K value of 80 has been used.
- Where possible / feasible, 110km/h design speed has been used, resulting in 1100 m curve radii for 4-lane compatibility.
- It is noted that lower vertical curve K values have been recently accepted by NZTA in constrained situations, an example being Christchurch Southern Motorway Phase 1, where it is understood a crest curve K value of 72 was accepted. The use of a relaxed K value has not been considered in detail as part of this PFR but should be considered in future to reduce the extents of bridging structures and approaches.
- Where the existing carriageway is retained, regrading the carriageway would not generally be required but new surfacing would be laid across the entire width and length of the project.
- Drainage provision has been included (subsoil drains, sums, culverts, headwalls) within the cost estimation but this is estimated based purely on the judgement of a drainage engineer.
- Clear zones have not been incorporated into the design. The provision of safety barrier has been allowed for in the options that include grade separation on the embankments and bridge structures.
- Earthwork batter slopes are assumed to be 6H:1V for fills and 3H:1V for cuts. Earthwork extents have been estimated as no topographical survey data is available.
- A standard pavement design of 350 mm subbase, 170 mm M4 type basecourse and two coat chipseal has been incorporated, based only on known projects in the general area.

9 Cost Estimates

The expected and 95th percentile estimates for the options are detailed in Table 9-1 below.

Table 9-1 : Cost Estimate

Option Description	Expected Estimate	95th Percentile Estimate

Option Description	Expected Estimate	95th Percentile Estimate
Option 1a – Grade separated SH1/57	$32.4M	$41.6M
Option 2 – SH1/57 Roundabout	$15.5M	$19.9M
Option 3a – Bifurcation North of Ohau	$46.8M	$60.2M
Option 4a – Bifurcation South of Ohau	$49.9M	$64.2M

To ensure consistency in comparison, all options have included an upgrade to SH1 between the Ohau River and 700 m north of the existing intersection with SH1/57 as per the typical cross-section shown in Figure 6-1. It is entirely feasible that all or part of this upgrade may not be required, dependent upon the preferred option(s).

The cost estimates for the options have been compiled using concept layouts of the options and with no survey data, and are based on the design statement assumptions as listed above. More detail of the cost estimates for the options are given in Appendix E.

Property costs have been included in the options cost estimation based upon information provided by NZTA to MWH in 2011[12]. These figures are calculated considering land use and zoning and applying a broad land value rate to the areas required for the improvements. Adjustments based on limited site visits have been made, but property remains a major risk item during this PFR stage.

10 Economic Assessment and Risk Assessment

10.1 Basis of Economic Analysis

Economic analysis was carried out in accordance with NZTA's Economic Evaluation Manual (EEM) using a modified version of the full procedures.

The intersection modelling software, Sidra, was used to model the existing T intersection using 2011 traffic counts to model for 2011 and 2041 time periods. Sidra models were also constructed for Options 5-1a and 5-2 as these options included the reconfiguration of the existing SH1/57 intersection. Options 5-3a and 5-4a utilise new route lengths for economic calculations as these options are for grade separated bifurcations between SH1/SH57, therefore removing the intersection conflict.

The do-minimum and options were assessed:

- Do Minimum (i.e. the existing T intersection)
- Option 5-1a (grade separated turns between SH1 & SH57 – with restricted movements)
- Option 5-2 (SH1/57 Roundabout)
- Option 5-3a (Bifurcation North of Ohau)
- Option 5-4a (Bifurcation South of Ohau)

The alternative options were not evaluated economically as at the feasibility stage it is considered that the main options provide sufficient direction on the likely costs and benefits of each option. The alternative options could be evaluated at the SAR stage as required.

The extent of the economic evaluation included SH1 north of the Ohau River Bridge, to the SH1/SH57 intersection, to the intersection of Kimberley Road / Arapaepae Road (both SH57). Each option consists of:

[12] Email provided from Mitchell Cocking (NZTA) to Marten Oppenhuis (MWH) on 12 August 2011

- Improvements to the SH1/SH57 connection (either improvements to the existing at-grade intersection form, grade separation or full bifurcation).
- Widening of SH1 to two 3.5 m traffic lanes and two 2.0 m sealed shoulders from the Ohau River to the point of separation between SH1/SH57 (either the intersection or the point of bifurcation).
- Widening of Kimberley Road to two 3.5 m traffic lanes and two 2.0 m sealed shoulders for that section that would remain SH57 (i.e. in Option 5-4a the new link would become SH57 and Kimberley Road reclassified as local road and therefore no improvements are proposed in that scenario).

The following assumptions have been made in the calculation of the Benefit Cost Ratio. They are:

1. The base year is 2011 (given date of traffic counts) and time zero is 2013.
2. A composite annual traffic growth is estimated as 2.0% using the EEM standard regional (Manawatu-Wangenui) rural strategic traffic growth figure rate (used as 3 count locations have different growth rates over the period 1992-2011)
3. Based on Traffic growth, the time zero (2013) AADT are calculated as[13]:
    a. SH1 South of SH1/57 intersection 16,100 vpd,
    b. SH North of SH1/57 Intersection 12,200 vpd,
    c. Kimberley Road, 5,000 vehicles vpd.
4. The crash analysis has been undertaken for the five calendar year period January 2007 – December 2011 and considers the following:
    a. Accident by Accident analysis for the Do-minimum scenario (i.e. Method A). The do-minimum crash cost for the five year period across the study area was calculated as $2.4m.
    b. Crash Rate for the Options (Method B) given there will be a fundamental change to the project area

10.1 Travel Time Analysis

The Travel Time is derived by utilising 2-lane rural road travel time analysis with free speed, and then the link travel time is combined with the volume and cost per KM for the route to derive the Travel Time Cost (TTC). For the do-minimum and options 5-1a and 5-2, where the options directly relate to an improvement at the intersection of SH1/57, Sidra has also been used to calculate intersection delays for the existing and proposed intersection arrangement. This figure is then combined with travel time for the remainder of the route and TTC's calculated for each option.

The Travel Time Costs are calculated as follows (in comparison to the do-minimum):

- Option 5-1a: 5% reduction
- Option 5-2: 2% increase
- Option 5-3a: 5% reduction
- Option 5-4a: 11% reduction

10.2 Vehicle Operating Cost

Using the Travel Time data, Vehicle Operating Costs (VOC) are calculated using the rural strategic standard traffic composition for all periods (as per Table A2.3). An allowance has also been made for an improvement in roughness as part of the new pavement construction (assumed existing situation has a roughness of 85 NASRA and the new construction would be 65 NASRA). Carbon dioxide emission savings are also calculated using the VOC data.

[13] The traffic figures for Time Zero (2013) are derived using previous 20 years traffic counts (only 18 years available for Kimberley Road) and linear regression.

The Vehicle Operating Costs are calculated as follows (in comparison to the do-minimum):

- Option 5-1a: 21% reduction
- Option 5-2: 2% reduction
- Option 5-3a: 18% reduction
- Option 5-4a: 22% reduction

10.3 Crash Benefits

The do-minimum scenario used the 5 year crash data for the network (and calculated as $2.4m). For the options, the crash rate was derived using the EEM crash rate models for mid-blocks and intersections.

The crash costs for the options were calculated as:

- Option 5-1a: $1.3M
- Option 5-2: $1.6M
- Option 5-3a: $1.3M
- Option 5-4a: $1.2M

For the grade separated options, a conservative approach has been adopted such that the two one-way ramp sections are considered as a single section of <80 km/h rural road. This is conservative because these are separated sections of highway and therefore the conflict is reduced (for example, there would be no head-on crashes in these situations). This method has been adopted as there is no other appropriate crash rate for ramps contained within the EEM.

10.4 Maintenance Costs

Future maintenance costs have been allowed for in the economic evaluation. An assumed maintenance intervention level has been used for the do-minimum. This includes:

- Year 8: Reseal,
- Year 17: Full pavement rehabilitation
- Year 18: Second coat seal at year 19
- Year 20: Mill / mix
- Year 27: A further reseal

10.5 Benefit Cost Ratio Results

Table 10-1: Economic Analysis Summary

Option Description	Total Cost (NPV)	Total Benefits (NPV)	BCR
Option 5-1a – Grade Separated Intersection	$27.9m	$65.1m	**2.3**
Option 5-2 –Roundabout	$13.2m	$12.8m	**1.0**
Option 5-3a – Bifurcation North	$40.4m	$74.9m	**1.9**
Option 5-4a – Bifurcation South	$44.0m	$87.2m	**2.0**

See Appendix F for economic evaluation cover sheets.

Option 5-1a has the greatest BCR and therefore purely in economic terms is favourable. However, this option also includes a significant initial capital cost to construct, as do Options 5-3a and 5-4a and may not be feasible due to affordability.

Whilst the Roundabout Solution (Option 5-2) has a BCR that demonstrates only marginal economic efficiency, the capital cost is significantly below the other 3 options and it would be advisable for further work to ascertain methods of improving this BCR prior to ruling this option out in future. Whilst all of the options include improvements beyond the intersection in isolation, the roundabout option is particularly vulnerable to the increased costs of this associated works because of the lesser value of benefits. The benefits are also compromised with a roundabout because all vehicles / movements are subject to delay which is not currently the case. In addition, this option also includes a section of route lengthening which has consequential effects for the overall benefits. It is possible that significant improvements to the overall BCR for this option could be realised with some refinement at the scheme stage. Option 5-2 could be investigated as more of a short-medium term solution though this some of the works would inevitably become abortive.

Option 5-3a exhibits a relatively similar capital cost to Option 5-4a but delivers less benefits and therefore should be omitted from further assessment.

Option 5-4a delivers significant benefits due to the route shortening and removal of the at-grade intersection but does require the greatest capital outlay.

The Options have also been considered in terms of incremental BCR, where it is demonstrated that Option 5-4a Bifurcation South is the preferred option.

Table 10-2: Incremental BCR of Project Options

Option Description	Next Higher Cost	Incremental BCR	Base for Next Step
Option 5-2 – Roundabout	Option 5-1a - Grade Separated Intersection	3.6	**Option 5-1a Grade Separated Intersection**
Option 5-1a - Grade Separated Intersection	Option 5-3a – Bifurcation North	0.8	**Option 5-1a Grade Separated Intersection**
Option 5-1a - Grade Separated Intersection	Option 5-4a – Birfurcation South	1.4	**Option 5-4a Grade Separated Intersection**

10.6 Risk Assessment

The risks to the project have been assessed using the General Approach as determined in the NZTA Risk Management Process Manual (AC/Man/1).

The major potential risks associated with the SH1 / SH57 / Arapaepae Curve improvement project are considered to be:

- Project unable to get funded due to constrained funding environment.
- Inaccurate cost estimate due to level of available data at this feasibility state, including utility information and assumptions in regards to topography and land value / use.
- Conceptual structures type / position are not achievable due to surrounding properties / land uses / other constraints.
- Incompatibility with adjacent sections improvement works (and preclusion of 4-laning opportunity)
- Traffic delays during construction.
- Environmental effects during construction & within the project.
- Impacts on existing services.
- Land acquisition difficulties
- Difficulties in obtaining resource consents and/or alteration to designation
- Opposition from local iwi
- Additional landowner accommodation works required

- Potential abortive work & redundancy that does not support the long term 4-laning solution

11 Assessment Profile

The Government Policy Statement on Land Transport Funding (GPS) requires the NZTA to consider a number of matters when evaluating projects. To assist in understanding how projects perform against these matters and hence what investment decisions to make, the NZTA utilises an assessment profile process.

The assessment profile is a three-part rating for an activity, rated as high, medium or low e.g. HMM, and representing the assessment for Strategic Fit, Effectiveness and Efficiency respectively.

Table 11-1 outlines the various options assessment profile[14] for the connection for the various options between SH1 and SH57 and the Arapaepae Curve.

Table 11-1: Waitarere Beach Road Curve assessment profile

Option	Strategic Fit	Effectiveness	Efficiency
Option 5-1a – Grade Separated Intersection	High	High	Medium
Option 5-2 – Roundabout	High	Medium	
Option 5-3a – Bifurcation North	High	High	Low
Option 5-4a – Bifurcation South	High	High	Low

11.1 Strategic Fit

The strategic fit factor is a measure of how an identified problem, issue or opportunity that is addressed by a proposed activity or combination of activities, aligns with the NZTA's strategic investment direction.

As this project is part of a Road of National Significance and is classified as a High Risk Rural Road, the Strategic Fit is **High** for all options.

11.2 Effectiveness

The effectiveness factor considers the contribution that the proposed solution makes to achieving the potential identified in the strategic fit assessment and to the purpose of the Land Transport Management Act (LTMA).

A wide range of assessment factors are available for use in this effectiveness rating and these draw from the five LTMA areas of:

- Economic Development
- Safety and Personal Security
- Access and Mobility
- Public Health
- Environmental Sustainability

[14] NZTA Planning and Investment Knowledge Base, www.pikb.co.nz/assessment-framework

A number of other key criteria need to be considered including integration, consideration of options and responsiveness.

As this project is part of the Roads of National Significance programme, it is recommended that the effectiveness factor for RoNS projects of **High** is adopted, Option 5-2 has been given an Effectiveness rating of **Medium** as it would not grade separate the traffic at the SH1/SH57 intersection.

This is considered appropriate as the project will contribute positively to safety and is consistent with NZTA's strategies and plans.

11.3 Efficiency

The economic efficiency assessment considers how well the proposed solution maximises the value of what is produced from the resources used. This is primarily undertaken by the Benefit Cost Ratio.

The Options range from 1.0 to 2.3 in terms of calculated BCRs. Options with a BCR of below 1.0 are considered to have 'no rating' and are considered economically inefficient. The Roundabout Option (Option 5-2) is marginal but three of the options have a BCR of between 1.0 and 2.0. Therefore they would be considered **Low** efficiency. Option 5-1a has a BCR between 2.0 and 4.0 so is considered **Medium** economic efficiency.

In reality, the roundabout option BCR of 1.0 is just on the threshold of a 'Low' categorisation but with relatively minor amendments or cost fluctuation could result in an improved BCR (for example if the alternative SH1 approach was selected as shown on drawing no. 80500902-05-001-C002).

12 Social and Environmental Assessment

The Scoping Report phase of the Ōtaki to Levin RoNS identified a number of social and environmental factors which will need to be assessed during any scheme assessment phase. These are outlined below.

- The Ohau River and adjacent river banks as being culturally significant
- The presence of a historically important building in Ohau (St John the Baptist Church),

Consultation has been carried out under the scoping phase of the Ōtaki to north of Levin RoNS and on-going consultation will continue with stakeholders throughout the planning and design process. The area is identified as being of cultural importance to the iwi of Rangitane o te Whanganui a Tara, Ngati Raukawa ki te Tonga and Ngati Toa Rangatira.

A Consultation Plan for the entire Ōtaki to north of Levin project will be required at the SAR stage and consultation will be undertaken in accordance with the plan. The purpose of the plan is to:

- Provide a documented process for intended engagement with the community, including the project context, the parties involved, and desired outcomes;
- Maximise effective and efficient engagement of community within generally tight time constraints;
- Provide the specifics of consultation to be undertaken, including timeframes;
- Help the project team to proactively manage risks to the project/project future from inappropriate or inadequate community engagement; and
- Help the project team to constructively manage community expectations.

13 Geotechnical Requirements

A preliminary geotechnical appraisal report was prepared by MWH in 2011. This report outlined that the majority of the stretch of the highway is underlained by beach deposits (Ōtaki Sandstone). To investigate the subsurface conditions along the alignment, which includes the study areas, MWH

recommended field investigations consisting of hand-auger bores, boreholes and test pits, depending on the location of proposed improvements.

The preliminary geotechnical appraisal report for the Ōtaki to Levin RoNS noted the following aspects in regards to the subject study areas:

- It has moderate settlement potential;
- It has a seismic potential due to the proximity of the active Northern Ohariu Fault;
- It has low susceptibility to liquefaction; and
- It is not located within a tsunami influence zone.

14 Land Requirements

Land requirement has been included in the concept development and cost estimation and uses the following assumptions:

- Option 5-1a requires 68,000 m^2 of land
- Option 5-2 requires 79,000 m^2 of land
- Option 5-3a requires 112,000 m^2 of land
- Option 5-4a requires 172,000 m^2 of land

The land calculations are based on that required for the construction of the road using aerial plan areas. It is entirely feasible that these areas will increases when property negotiations take place and entire properties are required to be purchased, with either on-sale value or additional land for the NZTA to maintain.

15 Resource Management Issues

The project must meet all statutory requirements. There are a number of documents (both statutory and non-statutory) that must be considered when planning for the state highway improvements. In particular, the requirements of the Resource Management Act, the Horowhenua District Plan and the Horizons Regional Plan (proposed One Plan) will be assessed to ensure that the proposed project meets the plan provisions and follows the statutory process.

15.1 District Plan Provisions

15.1.1 Designations

SH1 and SH57 are designated under the Horowhenua District Plan for “state highway purposes” (D2) and (D3) respectively. The existing designations are narrow in places and may need to be altered to accommodate the road improvements. Options requiring a realignment of sections of the highway may require a new designation. Accordingly, it is recommended that the designation boundaries be altered to accommodate these works under s181 RMA. NZTA will be required to give notice to the Council of its requirement to alter the designation (NOR). An outline plan will also be required to indicate the scale of the prosed works within the designation.

Alternatively, NZTA could apply for a resource consent (land use consent) to carry out the proposed works outside the designation.

A further designation in the vicinity of the proposed works is the Ohau Primary School in Muhunoa East Road, Ohau (D28) (Map 27) with the Ministry of Education being the designating authority.

15.1.2 Heritage Issues

Schedule 2 – Heritage Features of the District Plan identifies the St John the Baptist Church (Muhunoa East Road, Ohau) (H33) (Map 27) in the vicinity of the proposed works. This heritage building is located adjoining the Ohau Primary School.

15.2 Regional Plans

The final designs and construction plans will determine what regional consents are required. The options being investigated involve works that may include a bridge over the Ohau River.

The following resource consents are likely to be required under the proposed One Plan administered by the Horizon's Regional Council:

- Land use consents for the placement/extension of structures in the riverbed;
- Temporary diversions of water and takes of water during bridge construction;
- Bore permit for geotechnical investigation;
- Stormwater discharges from bulk earthworks;
- Soil and vegetation disturbance;
- Gravel extraction;
- Discharges of contaminants to land; and
- Discharge of contaminants to air from road construction.

15.3 Other Provisions

Given that the proposed works may involve earthworks on the river bank, there is the potential to unearth Maori artefacts. Current information does not identify any known sites but an archaeological authority may be required should a site be discovered.

16 Maintenance Issues

The current proposals would result in two specific changes to the maintenance regime:

- maintenance and repair of new bridge structures for the grade separated solutions
- maintenance of additional / new links (SH57 new bypass), and need to declassify existing State Highway to local road status.

Both these aspects have been included in the economic evaluations of the options.

17 Conclusions and Recommendations

This report explores the options for improving the connections between SH1 and SH57. The current intersection arrangement is a priority controlled T intersection with high volumes of turning traffic between the two State Highways. In addition the SH57 Arapaepae Road / Kimberley Road intersection is significantly below current geometric standards.

A number of options have been explored and all include improvements to SH1 from North of the Ohau River Bridge to Arapaepae Road. BCRs for each option have been calculated as being in the range of 1.0 to 2.3, with Option 5-2 (roundabout) having the lowest BCR and the grade separated SH1/57 intersection performing best, whilst the incremental BCR analysis demonstrates Option 5-4a (Bifurcation South) as performing best.

However, it should also be noted that the Capital Cost to construct the grade separated intersection (and both of the bifurcation options) is significantly greater than the capital cost for the Roundabout Option (Option 5-2) and this should be considered in terms of affordability and the overall short medium and long term strategy for this section of highway.

All options have been developed with due cognisance of the long term 4-laning solution and have been developed to avoid any unnecessary redundancy. The purpose of the PFR is to refine these options to be taken through to SAR. They are recommended to be; Option 5-1a & b, Option 2, Option 5-4a & b.

Appendix A Photographs

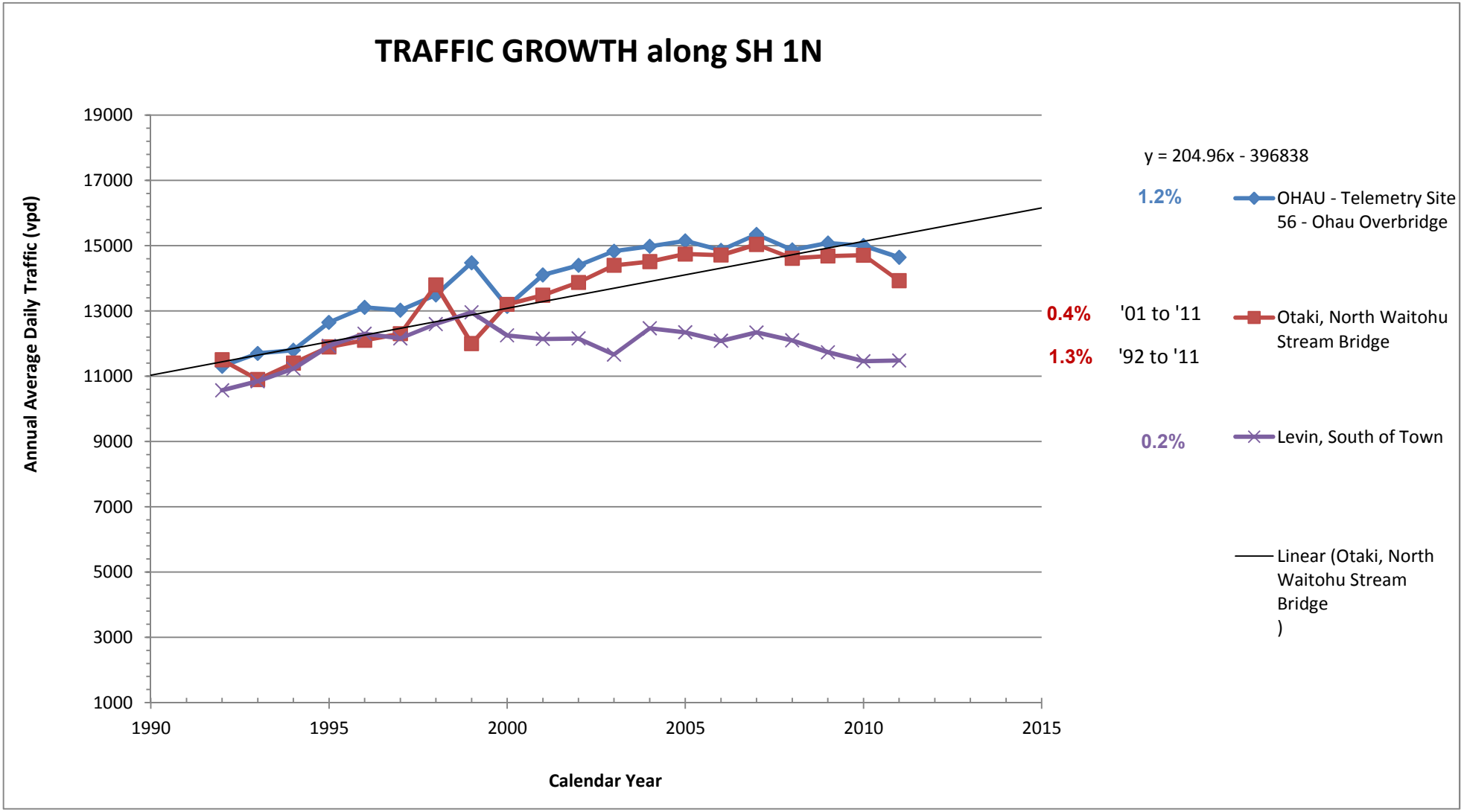
SH1/SH57 Intersection (northbound)

SH1 / SH 57 Intersection

SH57 Approach to SH1

SH57 Arapaepae Road approaching Kimberley Road

Appendix B Traffic Data


TRAFFIC GROWTH along SH 1N
Annual Average Daily Traffic (vpd)
19000
17000
15000
13000
11000
9000
7000
5000
3000
1000
1990
1995
2000
2005
2010
2015
Calendar Year
y = 204.96x - 396838
1.2%
OHAU - Telemetry Site 56 - Ohau Overbridge
0.4%
'01 to '11
Otaki, North Waitohu Stream Bridge
1.3%
'92 to '11
0.2%
Levin, South of Town
Linear (Otaki, North Waitohu Stream Bridge
)

Appendix C Crash Data

CRASH LIST DETAIL REPORT

Run on: 15 Aug 2012

Crash List: SH1 57 Kimberley (44 crashes)

Total Injury Crashes:	13
Total Non-Injury Crashes:	31
	44

Crash Type	Number	%
Overtaking Crashes:	3	7
Straight Road Lost Control/Head On:	8	18
Bend - Lost Control/Head On:	9	20
Rear End/Obstruction:	8	18
Crossing/Turning:	15	34
Pedestrian Crashes:	0	0
Miscellaneous Crashes:	1	2
TOTAL:	44	100 %

Location	Local road	%	St.Highway	%	Total	%
Urban	0	0	1	2	1	2
Open road	0	0	43	98	43	98
TOTAL:	0	0	44	100	44	100 %

Intersection/Midblock	Number	%
Intersection:	25	57
MidBlock:	19	43
TOTAL:	44	100 %

Environmental Factors	Number	%
Light/Overcast Crashes:	32	73
Dark/Twilight Crashes:	12	27
TOTAL:	44	100 %
Wet/Ice:	15	34
Dry:	29	66
TOTAL:	44	100 %

Day/Period	Number	%
Weekday	28	64
Weekend	16	36
TOTAL:	44	100 %

Vehicles	Number	%
Car	52	84
Van/Ute	6	11
Truck	5	9
Bus	0	0
Motorcycle	2	5
Bicycle	0	0
TOTAL:	65	109 %

Note: Percentages represent the % of crashes in which the vehicle, cause or object appears.

Crash factors (*)	Number	%
Alcohol	3	7
Too fast	6	14
Failed Giveway/Stop	13	30
Overtaking	1	2
Incorrect Lane/posn	5	11
Poor handling	3	7
Poor Observation	18	41
Poor judgement	12	27
Fatigue	3	7
Disabled/old/ill	1	2
Vehicle factors	4	9
Road factors	4	9
Weather	3	7
Other	3	7
TOTAL:	79	180 %
Crashes with a:		
Driver factor	65	148 %
Environmental factor	7	16 %

(*) factors are counted once against a crash - ie two fatigued drivers count as one fatigue crash factor.

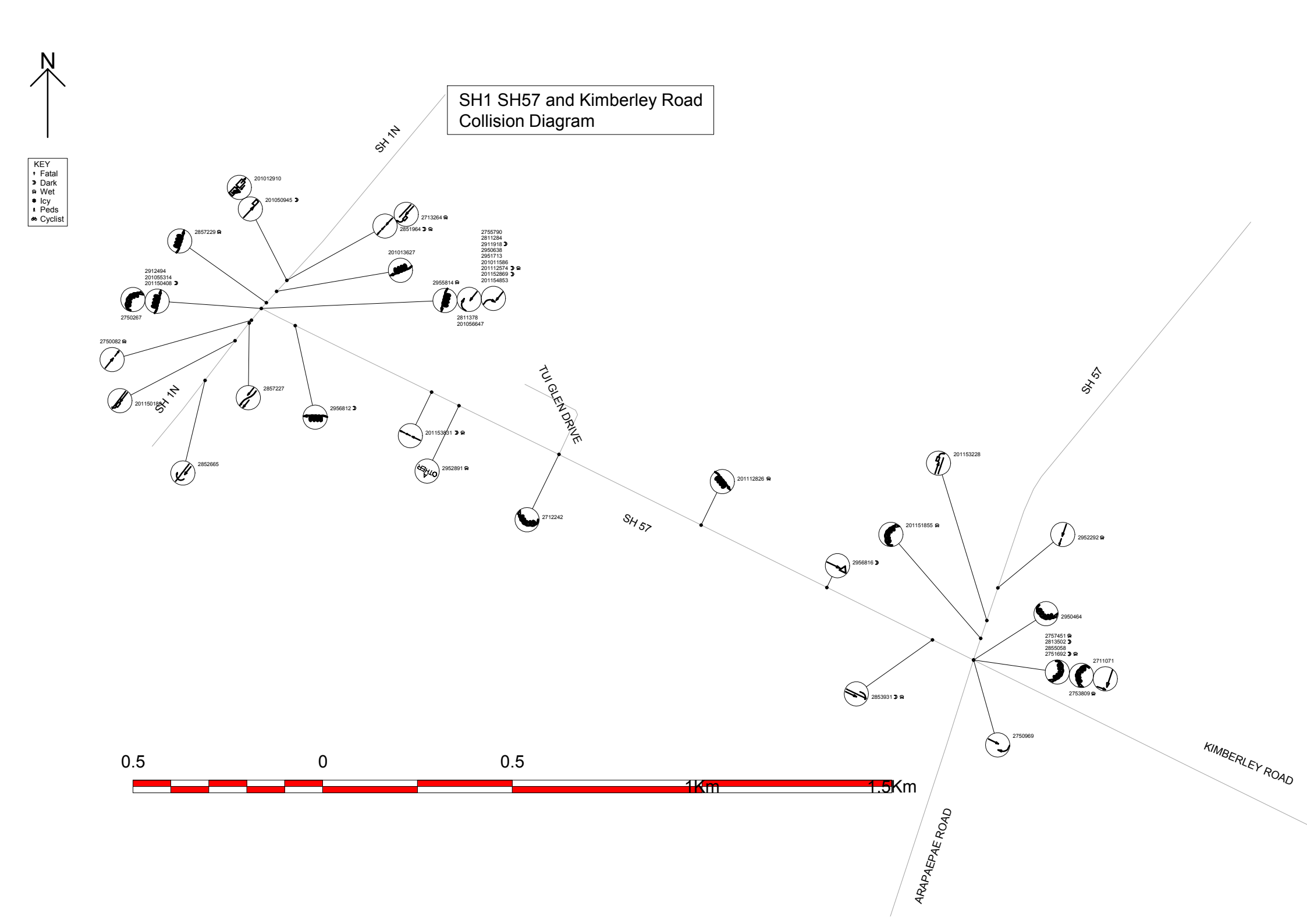
Note: Driver/vehicle factors are not available for non-injury crashes for Northland, Auckland, Waikato and Bay of Plenty before 2007. This will influence numbers and percentages.

Crashes with objects(s) struck	21	48 %

Object Struck	Number	%
Cliff Bank	1	2
Debris	1	2
Fence	9	20
Guard Rail	1	2
Parked Vehicle	1	2
Post Or Pole	4	9
Traffic Sign	7	16
Tree	2	5
Ditch	6	14
Stray Animal	1	2
TOTAL:	33	74 %

Crash Numbers

Year	Fatal	Serious	Minor	Non-Inj
2007	0	1	2	7
2008	0	0	3	6
2009	0	0	2	8
2010	0	1	2	3
2011	0	2	0	7
TOTAL:	0	4	9	31


N
SH1 SH57 and Kimberley Road
Collision Diagram
KEY
Fatal
Dark
Wet
Icy
Peds
Cyclist
SH 1N
SH 1N
TUI GLEN DRIVE
SH 57
SH 57
KIMBERLEY ROAD
ARAPAEPAE ROAD
201012910
201050945
2713264
2851964
2857229
201013627
2912494
201055314
201150408
2755790
2811284
2911918
2950638
2951713
201011586
201112574
201152869
201154853
2955814
2750267
2811378
201056647
2750082
201150188
2857227
2956812
2852665
201153931
OTHER
2952891
2712242
201112826
201153228
201151855
2956816
2952292
2950464
2757451
2813502
2855058
2751692
2711071
2753809
2853931
2750969
0.5
0
0.5
1Km
1.5Km

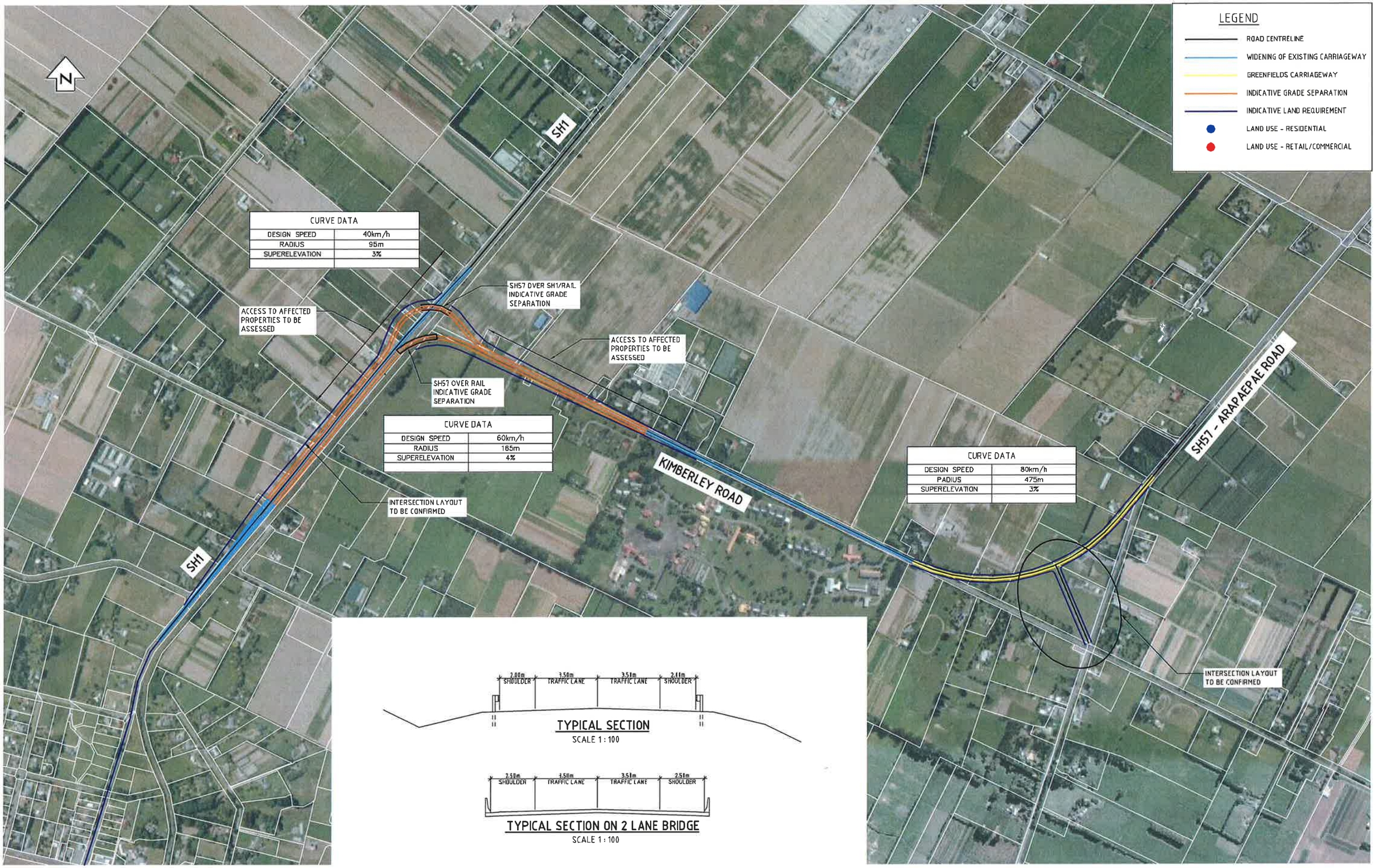
SH1/SH57 CODED CRASH DATA

CRASH RO/	CRASH DIS	CRASH DIR	INTSN	SIDE ROAD	CRASH ID	CRASH DATE	CRASH DO\	CRASH TIM	MVMT	VEHICLES	CAUSES	OBJECTS ST	ROAD CUR	ROAD WET	LIGHT	WTHRa	JUNC TYPE	TRAF CTRL	ROAD MAR	SPD LIM	CRASH FAT	CRASH SEV	CRASH MIN	PERS AGE1	PERS AGE2	EASTING	NORTHING
1N/967/17	100	N		KIMBERLEY	2.01E+08	23/09/2010	Thu	1230	QG	TN1T	682A	DF	R	D	B	FS		N	C	100	0	1	0			1791178	5497937
1N/967/17	100	N		KIMBERLEY	2713264	8/10/2007	Mon	1410	GC	CS1P	174B 372B	927	R	W	O	L	D	N	L	100	0	0	1			1791178	5497937
1N/967/17	100	N		SH 57	2.01E+08	13/03/2010	Sat	2109	EA	CN1C	352A 441B	M	E	D	DO	F		N	L	100	0	0	0			1791178	5497937
1N/967/17	100	N		SH 57	2851964	27/04/2008	Sun	1840	FD	CS1CCV	331A 351A	181D	R	W	DN	H		N	C	100	0	0	0			1791178	5497937
1N/967/17	60	N		SH 57	2.01E+08	25/12/2010	Sat	1315	CC	CS1	103A	F	R	D	B	F		N	L	100	0	0	1			1791151	5497908
1N/967/17	20	N		SH 57 KIME	2857229	30/12/2008	Tue	1157	CB	CN1	130A 354A	P	R	W	O	F		N	C	100	0	0	0			1791124	5497878
1N/985/0			I	KIMBERLEY	2912494	30/07/2009	Thu	1150	CB	CN1	350A 363A	FS	R	D	B	F	T	G	C	100	0	0	1			1791111	5497863
1N/985/0			I	KIMBERLEY	2.01E+08	14/10/2010	Thu	1620	CB	CN1	350A 403A	FPS	R	D	B	F	T	G	R	100	0	0	0			1791111	5497863
1N/985/0			I	KIMBERLEY	2750267	2/02/2007	Fri	1940	DA	4N1	501A	FS	R	D	B	F	T	S	C	100	0	0	0			1791111	5497863
1N/985/0			I	KIMBERLEY	2.01E+08	2/04/2010	Fri	1010	LB	CS1C	303B 382B	404B	R	D	O	F	T	G	R	100	0	0	5			1791111	5497863
1N/985/0			I	KIMBERLY I	2950638	22/02/2009	Sun	1630	LB	TS1C	303B 386B		R	D	B	F	T	S	R	100	0	0	0			1791111	5497863
1N/985/0			I	KIMBERLY I	2.01E+08	8/10/2010	Fri	1730	JA	4S1C	670A 302B	375B	R	D	O	F	T	G	C	100	0	0	0			1791111	5497863
1N/985/0			I	SH 57	2811378	25/03/2008	Tue	921	JA	VS14	302B 363B	375B	R	D	B	F	T	G	R	100	0	0	1			1791111	5497863
1N/985/0			I	SH 57	2811284	2/02/2008	Sat	1856	LB	CS1C	303B 375B		R	D	B	F	T	G	R	100	0	0	2			1791111	5497863
1N/985/0			I	SH 57	2755790	11/10/2007	Thu	1528	LB	4S1C	303B 375B		R	D	B	F	T	G	C	100	0	0	0			1791111	5497863
1N/985/0			I	SH 57	2.01E+08	10/02/2011	Thu	45	CB	CN1	410A	S	R	D	DO	F	T	N	L	100	0	0	0			1791111	5497863
1N/985/0			I	SH 57	2.01E+08	16/06/2011	Thu	1819	LB	CS1T	692A 303B		R	D	TO	F	T	G	R	80	0	0	0			1791111	5497863
1N/985/0			I	SH 57	2955814	18/11/2009	Wed	910	CB	CS1	112A 823 9	CV	R	W	O	H	T	S	R	100	0	0	0			1791111	5497863
1N/985/0			I	SH 57	2.01E+08	7/11/2011	Mon	1405	LB	CS1C	303B 382B		R	D	B	F	T	G	C	80	0	0	0			1791111	5497863
1N/985/0			I	SH 57	2951713	14/04/2009	Tue	1656	LB	CS1C	303B		R	D	O	F	T	G	P	100	0	0	0			1791111	5497863
1N/985/0			I	SH 57	2911918	3/05/2009	Sun	1721	LB	VS1V	303B 387B		R	D	TO	F	T	G	P	100	0	0	1			1791111	5497863
1N/985/0			I	SH 57 KIME	2.01E+08	11/09/2011	Sun	1930	LB	4S1C	303B 386B	S	R	W	DO	L	T	G	C	100	0	1	2			1791111	5497863
1N/985/0.0	40	S		SH 57	2750082	14/01/2007	Sun	1108	FA	4N1C	386A		R	W	O	L		N	C	100	0	0	0			1791085	5497832
1N/985/0.0	50	S		SH 57 KIME	2857227	12/12/2008	Fri	1652	AA	CS1C	372A		R	D	O	F		N	C	100	0	0	0			1791079	5497825
1N/985/0.1	110	S		SH 57	2.01E+08	22/01/2011	Sat	1340	GD	CS1CC	331A 353A	402A 921	R	D	O	F	D	N	L	100	0	0	0			1791042	5497778
1N/985/0.2	240	S		SH 57	2852665	30/05/2008	Fri	1130	MC	4S1C	372B		R	D	B	F		N	L	100	0	0	0			1790963	5497674
57/0/0.1	100	E		SH 1N	2956812	17/10/2009	Sat	512	CB	TW1	129A 410A	V	R	D	DF	F		N	C	100	0	0	0			1791200	5497818
57/0/0.5	500	E		SH 1N	2.01E+08	25/04/2011	Mon	1808	FD	CW1CC	181A 331A	352A 801	R	W	DN	L		N	C	100	0	0	0			1791559	5497643
57/0/0.58	580	E		SH 1N	2952891	8/05/2009	Fri	1135	AO	CW1C	357A 512A		R	W	O	H		N	L	60	0	0	0			1791631	5497607
57/0/0.873			I	TUI GLEN D	2712242	1/06/2007	Fri	1100	DA	MW1	613A		R	D	O	F	T	G	L	100	0	0	1			1791894	5497479
57/0/1.29	800	W		ARAPAEPA	2.01E+08	12/10/2011	Wed	1455	CC	CE1	130A 350A	TV	R	W	O	H		N	C	100	0	1	0			1792268	5497293
57/0/1.66	430	W		ARAPAEPA	2956816	24/12/2009	Thu	2130	EC	CE1	914	W	R	D	DN	F		N	C	100	0	0	0			1792599	5497129
57/0/1.97	120	W		ARAPAEPA	2853931	2/08/2008	Sat	1815	GE	CE1V	160A 387A	V	R	W	DN	L	D	N	C	100	0	0	0			1792877	5496991
57/0/2.083			I	KIMBERLEY	2750969	10/03/2007	Sat	1450	JA	CE2C	113A 302A		M	D	B	F	X	G	R	100	0	0	0			1792985	5496938
57/0/2.09			I	ARAPAEPA	2753809	1/07/2007	Sun	1828	DB	CW1	335A 400A	FT	R	W	O	L	X	G	C	100	0	0	0			1792985	5496938
57/0/2.09			I	KIMBERLEY	2757451	9/12/2007	Sun	1541	DA	CS1	111A 135A	FP	R	W	O	H	X	N	R	100	0	0	0			1792985	5496938
57/0/2.09			I	KIMBERLEY	2855058	15/07/2008	Tue	1622	DA	CS1	111A	FS	R	D	B	F	X	S	P	100	0	0	0			1792985	5496938
57/0/2.09			I	KIMBERLEY	2711071	4/01/2007	Thu	1020	HA	4S1C	302B	S	S	D	B	F	X	G	C	100	0	2	1			1792985	5496938
57/0/2.09			I	KIMBERLEY	2751692	27/02/2007	Tue	15	DA	CW1	111A 135A	FGV	R	W	DO	L	X	G	C	100	0	0	0			1792985	5496938
57/0/2.09			I	KIMBERLEY	2813502	15/11/2008	Sat	623	DA	CS1	103A 132A	V	R	D	DO	F	X	S	R	100	0	0	3			1792985	5496938
57/0/2.09			I	KIMBERLEY	2950464	21/02/2009	Sat	1620	DB	CE1V	111A		R	D	B	F	X	G	P	100	0	0	0			1792985	5496938
57/0/2.15	60	S		KIMBERLEY	2.01E+08	5/04/2011	Tue	1035	DA	4N1	410A	P	E	W	O	H		N	C	100	0	0	0			1793004	5496995
57/0/2.2	110	N		KIMBERLEY	2.01E+08	22/08/2011	Mon	1530	GC	4N1C	370A 330B	372B 926	R	D	B	F	D	N	C	100	0	0	0			1793020	5497042
57/0/2.29	200	N		KIMBERLEY	2952292	6/05/2009	Wed	735	FA	CS1C	101A 386A		R	W	O	H		N	C	100	0	0	0			1793049	5497128

Appendix D Outline Plans

DO NOT SCALE - IF IN DOUBT, ASK

ORIGINAL SIZE A1



NOT FOR CONSTRUCTION

REV	REVISIONS	BY	CHK	APP	DATE
A	PRELIMINARY	BT	PP	PP	08.02.13

SURVEYED	-	
DESIGNED	B. Browne	11/12
DRAWN	B. Timblick	11/12
CAD REVIEW		
DESIGN CHECK	P. Peet	11/12
DESIGN REVIEW	M. Oppenhuis	11/12
APPROVED	P. Peet	11/12
PROF REGISTRATION		

MWH

Client: NZ TRANSPORT AGENCY

NZ TRANSPORT AGENCY
OTAKI TO LEVIN PFRs

OPTION 5-1A : CONCEPTUAL GRADE SEPARATED RIGHT & LEFT TURN FROM SH1 TO SH57

Status Stamp: PRELIMINARY

Date Stamp: 08 FEB 2013

Scales: 1 : 5000, 1 : 100

Drawing No.: 80500902-05-001-C001a Rev. A

DO NOT SCALE - IF IN DOUBT, ASK

ORIGINAL SIZE A1

N

SH1

CURVE DATA	
DESIGN SPEED	40km/h
RADIUS	95m
SUPERELEVATION	3%

SH57 OVER SH1/RAIL
INDICATIVE GRADE
SEPARATION

AT GRADE MOVEMENTS
TO BE CONSIDERED

INTERSECTION LAYOUT
TO BE CONFIRMED

KIMBERLEY ROAD

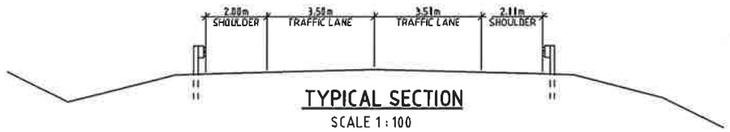
SH57 - ARAPAEPAE ROAD

CURVE DATA	
DESIGN SPEED	80km/h
RADIUS	475m
SUPERELEVATION	3%

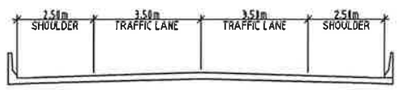
INTERSECTION LAYOUT
TO BE CONFIRMED

LEGEND

- ROAD CENTRELINE
- WIDENING OF EXISTING CARRIAGEWAY
- GREENFIELDS CARRIAGEWAY
- INDICATIVE GRADE SEPARATION
- INDICATIVE LAND REQUIREMENT
- LAND USE - RESIDENTIAL
- LAND USE - RETAIL/COMMERCIAL



TYPICAL SECTION
SCALE 1:100



TYPICAL SECTION ON 2 LANE BRIDGE
SCALE 1:100

NOT FOR CONSTRUCTION

REV	REVISIONS	DRN	CHK	APP	DATE
A	PRELIMINARY	BT	PP	MD	08.02.13

SURVEYED	-	
DESIGNED	B. Browne	11/12
DRAWN	B. Timblick	11/12
CAD REVIEW	-	-
DESIGN CHECK	-	-
DESIGN REVIEW	M. Oppenhuis	11/12
APPROVED	P. Peet	11/12
PROFREGISTRATION	-	

MWH

Client: NZ TRANSPORT AGENCY

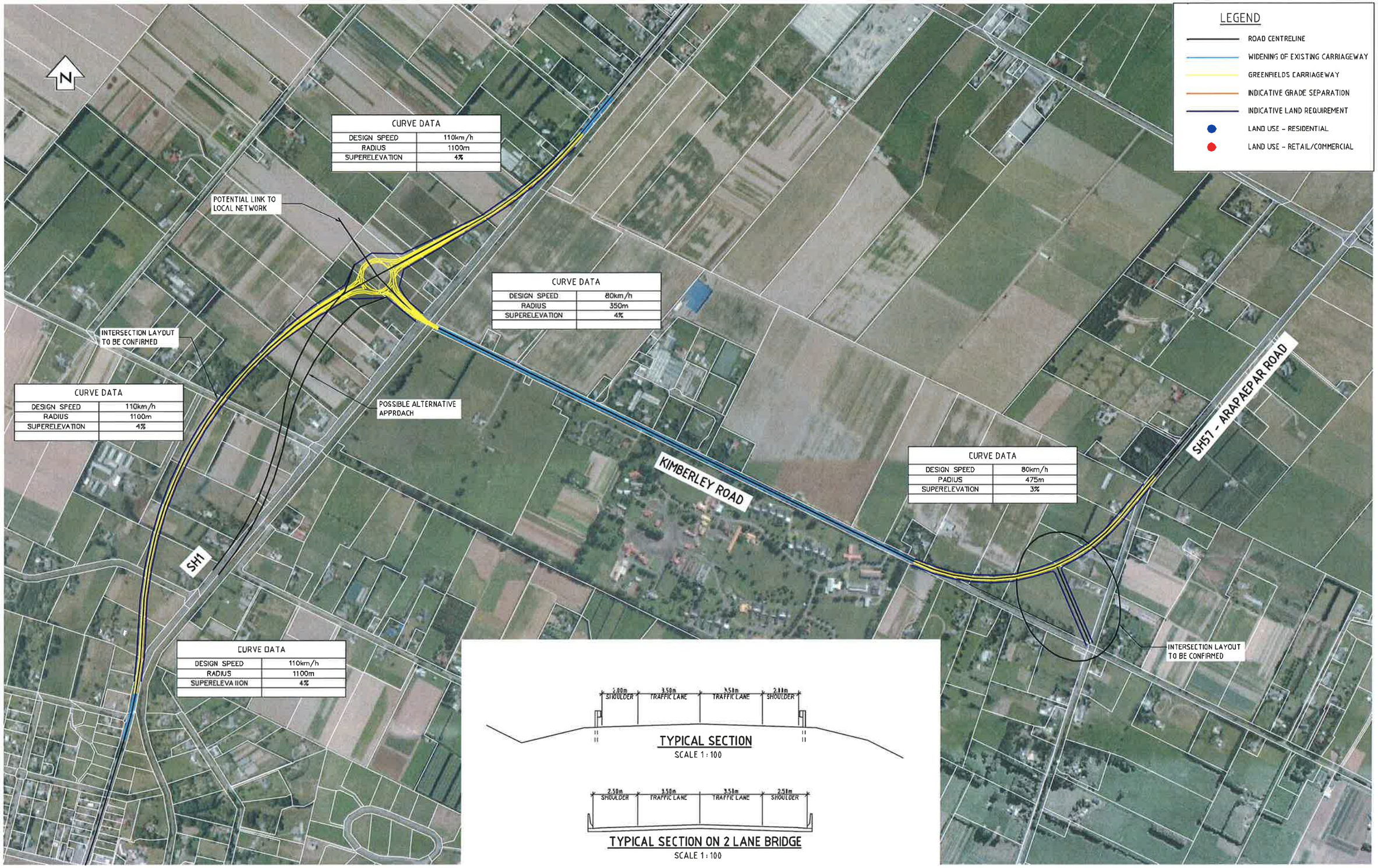
NZ TRANSPORT AGENCY
OTAKI TO LEVIN PFRs

OPTION 5-1B
CONCEPTUAL GRADE SEPARATION, NO LEFT TURN SEPARATION

Status Stamp: PRELIMINARY
Date Stamp: 08 FEB 2013
Scales: 1:5000, 1:100
Drawing No.: 80500902-05-001-C001b
Rev: A

DO NOT SCALE - IF IN DOUBT, ASK

ORIGINAL SIZE A1



NOT FOR CONSTRUCTION

REV	REVISIONS	DRN	CHK	APP	DATE
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SURVEYED	-	
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DRAWN	B. Timblick	11/12
CAD REVIEW		
DESIGN CHECK	P. Peet	11/12
DESIGN REVIEW	M. Oppenhuis	11/12
APPROVED	P. Peet	11/12
PROF REGISTRATION		

MWH

Client: NZ TRANSPORT AGENCY WAKA KOTAHI

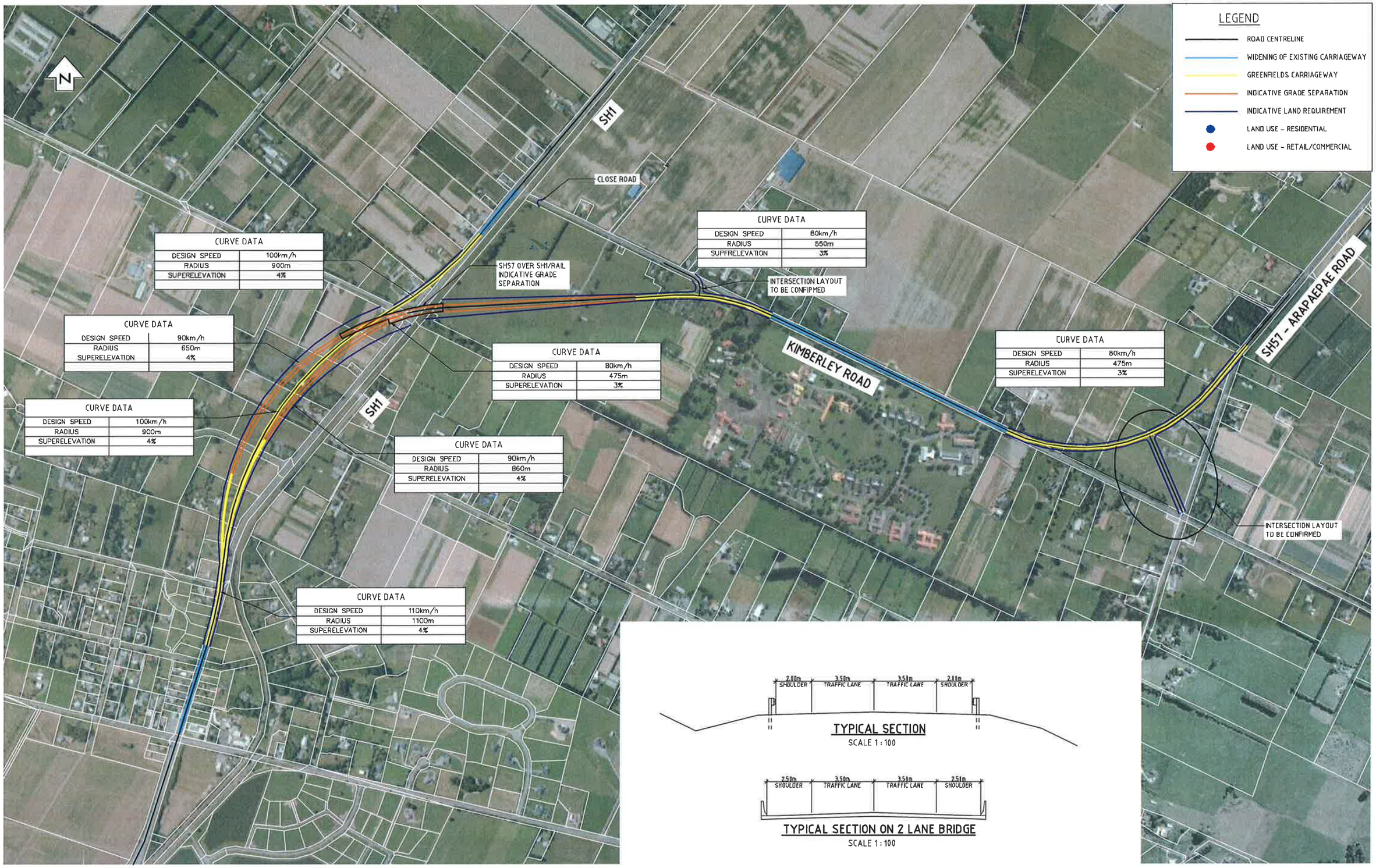
NZ TRANSPORT AGENCY
OTAKI TO LEVIN PFRs

OPTION 5-2
CONCEPTUAL SH1 / SH57 ROUNDABOUT

Status Stamp: PRELIMINARY
Date Stamp: 08 FEB 2013
Scales: 1:5000, 1:100
Drawing No.: 80500902-05-001-C002
Rev: A

DO NOT SCALE - IF IN DOUBT, ASK

ORIGINAL SIZE A1



CURVE DATA	
DESIGN SPEED	100km/h
RADIUS	900m
SUPERELEVATION	4%

CURVE DATA	
DESIGN SPEED	80km/h
RADIUS	550m
SUPERELEVATION	3%

CURVE DATA	
DESIGN SPEED	90km/h
RADIUS	650m
SUPERELEVATION	4%

CURVE DATA	
DESIGN SPEED	80km/h
RADIUS	475m
SUPERELEVATION	3%

CURVE DATA	
DESIGN SPEED	80km/h
RADIUS	475m
SUPERELEVATION	3%

CURVE DATA	
DESIGN SPEED	100km/h
RADIUS	900m
SUPERELEVATION	4%

CURVE DATA	
DESIGN SPEED	90km/h
RADIUS	860m
SUPERELEVATION	4%

CURVE DATA	
DESIGN SPEED	110km/h
RADIUS	1100m
SUPERELEVATION	4%

TYPICAL SECTION
SCALE 1:100

TYPICAL SECTION ON 2 LANE BRIDGE
SCALE 1:100

NOT FOR CONSTRUCTION

REV	REVISIONS	BY DRN	PP CHK	PP APP	DATE
A	PRELIMINARY	BT	PP	PP	18.02.13

SURVEYED	-	
DESIGNED	B. Browne	11/12
DRAWN	B. Timblick	11/12
CAD REVIEW		
DESIGN CHECK	P. Peet	11/12
DESIGN REVIEW	M. Oppenhuis	11/12
APPROVED	P. Peet	11/12
PROF REGISTRATION	-	

MWH

Client: NZ TRANSPORT AGENCY WAKA KOTAHI

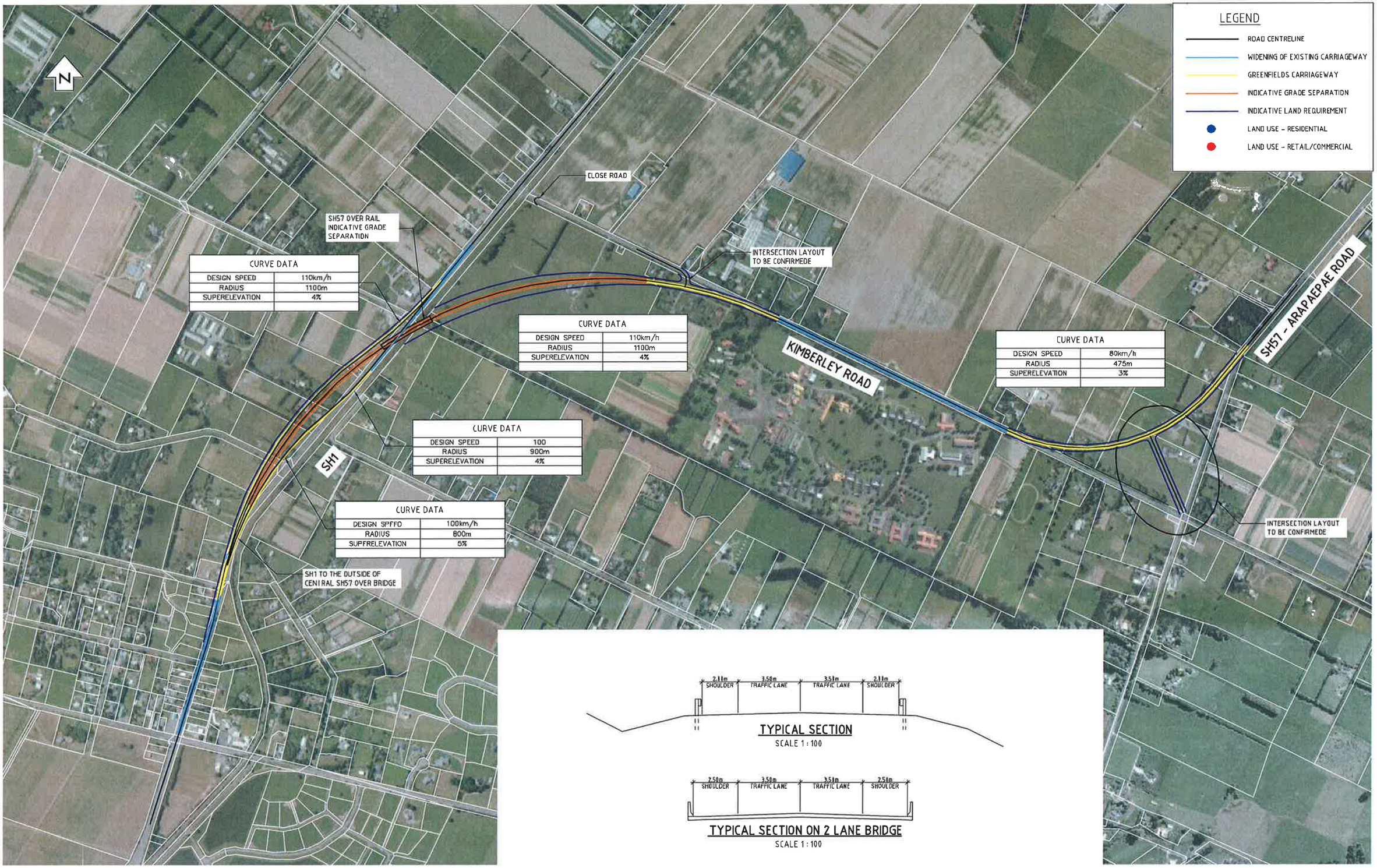
NZ TRANSPORT AGENCY
OTAKI TO LEVIN PFRs

OPTION 5-3A
CONCEPTUAL BIFURCATION NORTH OF OHAU

Status Stamp: PRELIMINARY
Date Stamp: 08 FEB 2013
Scales: 1:5000, 1:100
Drawing No.: 80500902-05-001-C003a
Rev: A

DO NOT SCALE - IF IN DOUBT, ASK

ORIGINAL SIZE A1



NOT FOR CONSTRUCTION

REV	REVISIONS	DRN	CHK	APP	DATE
A	PRELIMINARY	BT	PP	PP	18.02.13

SURVEYED	-	
DESIGNED	B. Browne	11/12
DRAWN	B. Timblick	11/12
CAD REVIEW		
DESIGN CHECK	P. Peet	11/12
DESIGN REVIEW	M. Oppenhuis	11/12
APPROVED	P. Peet	11/12
PROF REGISTRATION	-	

MWH ©

Client: NZ TRANSPORT AGENCY WAKA KOTAHI

NZ TRANSPORT AGENCY
OTAKI TO LEVIN PFRs

OPTION 5-3B
CONCEPTUAL BIFURCATION NORTH OF OHAU ALTERNATIVE

Status Stamp: WORKING PLOT
Date Stamp: 08 FEB 2013
Scales: 1:5000, 1:100
Drawing No.: 80500902-05-001-C003b
Rev.: A

DO NOT SCALE - IF IN DOUBT, ASK

ORIGINAL SIZE A1

CLOSE KIMBERLY ROAD PRIOR TO RAIL CROSSING

KIMBERLEY ROAD

SH1

CLOSE ROAD

CURVE DATA	
DESIGN SPEED	110km/h
RADIUS	1100m
SUPERELEVATION	3%

INTERSECTION LAYOUT TO BE CONFIRMED

INTERSECTION LAYOUT TO BE CONFIRMED

CURVE DATA	
DESIGN SPEED	110km/h
RADIUS	1100m
SUPERELEVATION	3%

INTERSECTION LAYOUT TO BE CONFIRMED

MUHUNDA EAST ROAD

BISHOPS ROAD

SH57 OVER RAIL INDICATIVE GRADE SEPARATION

CURVE DATA	
DESIGN SPEED	90km/h
RADIUS	600m
SUPERELEVATION	4%

SH57 OVER SH1 INDICATIVE GRADE SEPARATION

SEE MANAKAU TO OHAU PFR

CURVE DATA	
DESIGN SPEED	80km/h
RADIUS	475m
SUPERELEVATION	3%

CURVE DATA	
DESIGN SPEED	110km/h
RADIUS	1100m
SUPERELEVATION	3%

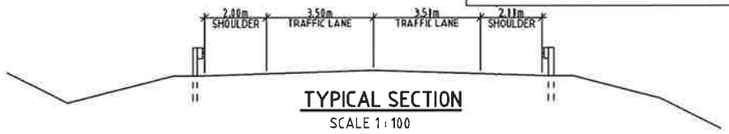
CURVE DATA	
DESIGN SPEED	100km/h
RADIUS	950m
SUPERELEVATION	4%

SH1

OHAU RIVER

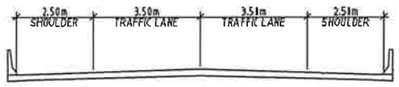
LEGEND

- ROAD CENTRELINE
- WIDENING OF EXISTING CARRIAGEWAY
- GREENFIELDS CARRIAGEWAY
- INDICATIVE GRADE SEPARATION
- INDICATIVE LAND REQUIREMENT
- LAND USE - RESIDENTIAL
- LAND USE - RETAIL/COMMERCIAL



TYPICAL SECTION

SCALE 1:100



TYPICAL SECTION ON 2 LANE BRIDGE

SCALE 1:100

NOT FOR CONSTRUCTION

REV	REVISIONS	DRN	CHK	APP	DATE
A	PRELIMINARY	BT	PP	FP	08.02.13

SURVEYED	-	
DESIGNED	B. Browne	11/12
DRAWN	B. Timblick	11/12
CAD REVIEW	-	-
DESIGN CHECK	P. Peet	11/12
DESIGN REVIEW	M. Oppenhuis	11/12
APPROVED	P.Peet	11/12
PROF REGISTRATION	-	

MWH

Client: NZ TRANSPORT AGENCY WAKA KOTAHI

NZ TRANSPORT AGENCY
OTAKI TO LEVIN PFRs

OPTION 5-4a
CONCEPTUAL LINK TO OHAU STRAIGHT (REF)

Status Stamp: PRELIMINARY

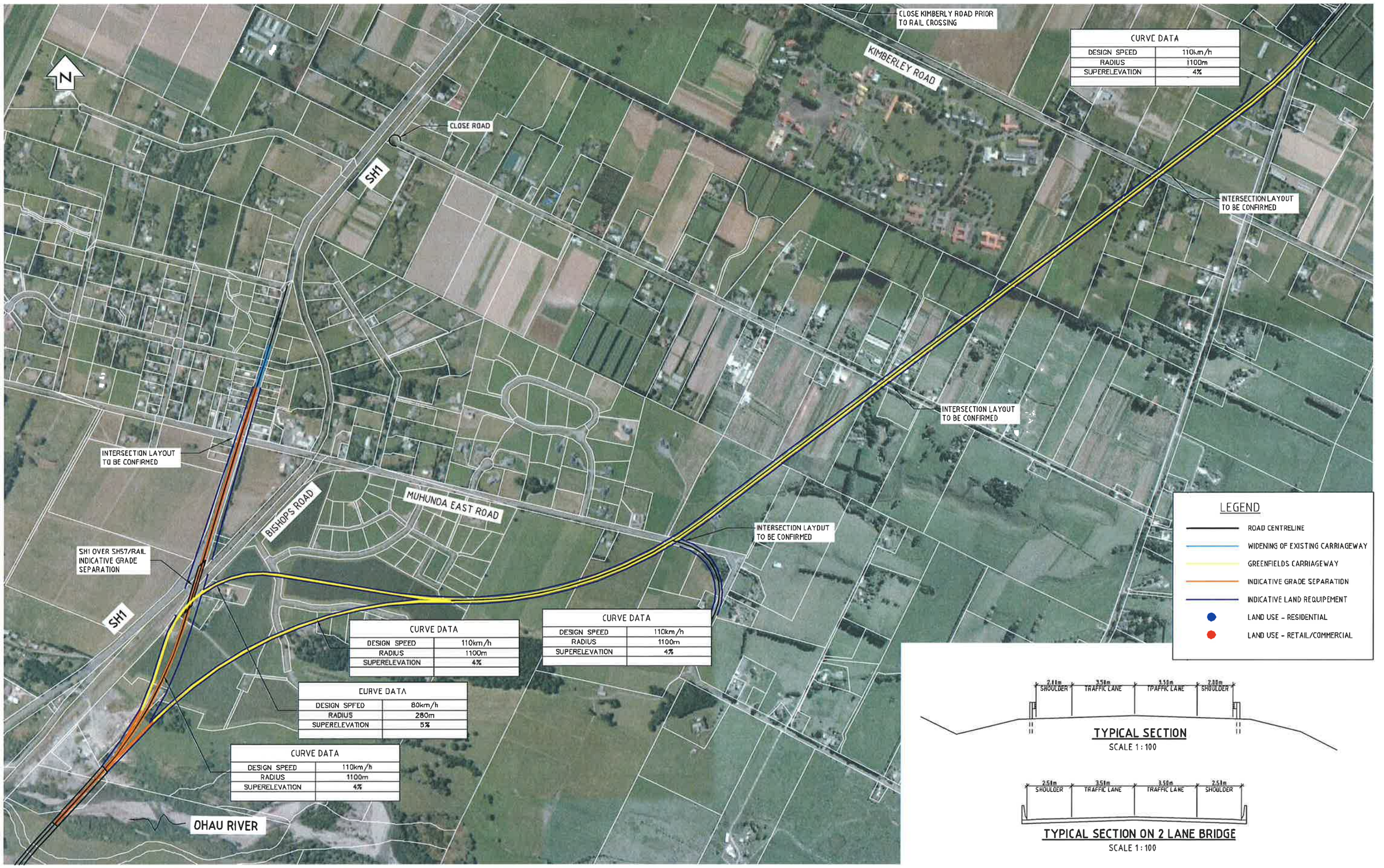
Date Stamp: 08 FEB 2013

Scales: 1:5000, 1:100

Drawing No.: 80500902-05-001-C004a Rev. A

DO NOT SCALE - IF IN DOUBT, ASK

ORIGINAL SIZE A1



TYPICAL SECTION
SCALE 1:100

TYPICAL SECTION ON 2 LANE BRIDGE
SCALE 1:100

NOT FOR CONSTRUCTION

REV	REVISIONS	BY DRN	PP CHK	PP APP	DATE
A	PRELIMINARY	BT	PP	PP	18.02.13

SURVEYED	-	
DESIGNED	B. Browne	11/12
DRAWN	B. Tisblick	11/12
CAD REVIEW		
DESIGN CHECK	P. Peet	11/12
DESIGN REVIEW	M. Oppenhuis	11/12
APPROVED	P. Peet	11/12
PROF REGISTRATION		

MWH

Client: NZ TRANSPORT AGENCY WAKA KOTAHI

NZ TRANSPORT AGENCY
OTAKI TO LEVIN PFRs

OPTION 5-4b
CONCEPTUAL EASTERN RIVER CROSSING

Status Stamp: WORKING PLOT
Date Stamp: 08 FEB 2013
Scales: 1:5001, 1:100
Drawing No.: 80500902-05-001-C004b
Rev.: A

Appendix E Cost Estimates

Project Estimate - Form A

Project Name: Otaki to Levin PFR Study
PFR 5 (SH1/57 Arapaepae)
Option 5-1a Grade Separation

FE
Feasibility Estimate

Item	Description	Base Estimate	Contingency	Funding Risk
A	**Nett Project Property Cost**	970,000	194,000	320,100
	Investigation and Reporting			
	- Consultancy Fees	1,080,000	216,000	356,400
	- NZTA-Managed Costs	0	0	0
B	**Total Investigation and Reporting**	1,080,000	216,000	356,400
	Design and Project Documentation			
	- Consultancy Fees	1,080,000	216,000	356,400
	- NZTA-Managed Costs	0	0	0
C	**Total Design and Project Documentation**	1,080,000	216,000	356,400
	Construction			
	MSQA			
	- Consultancy Fees	1,080,000	216,000	356,400
	- NZTA-Managed Costs	0	0	0
	- Consent Monitoring Fees	0	0	0
	Sub Total Base MSQA	1,080,000	216,000	356,400
	Physical Works			
D1	Environmental Compliance	1,000,000	200,000	330,000
D2	Earthworks	1,735,000	520,500	867,500
D3	Ground Improvments	367,500	73,500	121,300
D4	Drainage	1,514,500	302,900	499,800
D5	Pavement and Surfacing	2,894,250	578,900	955,100
D6	Bridges / Structures	4,900,000	980,000	1,617,000
D7	Retaining Walls	705,000	141,000	232,700
D8	Traffic Services	526,250	105,300	173,700
D9	Service Relocations	1,687,500	337,500	556,900
D10	Landscaping	827,000	165,400	272,900
D11	Traffic Management and Temporary Works	2,500,000	500,000	825,000
D12	Preliminary and General	4,000,000	800,000	1,320,000
D13	Extraordinary Construction Costs	0	0	0
	Sub Total Base Physical Works	22,657,000	4,705,000	7,771,900
D	**Total Construction & MSQA**	23,737,000	4,921,000	8,128,300
E	**Project Base Estimate** (A+B+C+D)	26,867,000		
F	**Contingency** (Assessed / Analysed) (A+B+C+D)		5,547,000	
G	**Project Expected Estimate** (E+F)		32,414,000	
	Project Property Cost Expected Estimate		1,164,000	
	Investigation and Reporting Expected Estimate		1,296,000	
	Design and Project Documentation Expected Estimate		1,296,000	
	Construction Expected Estimate		28,658,000	
H	**Funding Risk** (Assessed / Analysed) (A+B+C+D)			9,161,200
I	**95th Percentile Project Estimate** (G+H)			41,575,200
	Project Property Cost 95th Percentile Estimate			1,484,100
	Investigation and Reporting 95th Percentile Estimate			1,652,400
	Design and Project Documentation 95th Percentile Estimate			1,652,400
	Construction 95th Percentile Estimate			36,786,300

Base Date of Estimate	**8 Nov 2012**	**Cost Index**
Estimate prepared by:	**Jamie Povall**	**Signed**
Estimate internal peer review by:	**Marten Oppenhuis**	**Signed**
Estimate external peer review by:		**Signed**
Estimate approved by NZTA Project Manager:		**Signed**

Note: (1) These estimates are exclusive of escalation and GST.

Project Estimate - Form A

Project Name: Otaki to Levin PFR Study - PFR 5 (SH1/57 Arapaepae), Option 5-2

FE

Feasibility Estimate

Item	Description	Base Estimate	Contingency	Funding Risk
A	**Nett Project Property Cost**	**990,000**	**198,000**	**326,700**
	Investigation and Reporting			
	- Consultancy Fees	**280,000**	**56,000**	**92,400**
	- NZTA-Managed Costs	**0**	**0**	**0**
B	**Total Investigation and Reporting**	**280,000**	**56,000**	**92,400**
	Design and Project Documentation			
	- Consultancy Fees	**560,000**	**112,000**	**184,800**
	- NZTA-Managed Costs	**0**	**0**	**0**
C	**Total Design and Project Documentation**	**560,000**	**112,000**	**184,800**
	Construction			
	MSQA			
	- Consultancy Fees	**560,000**	**112,000**	**184,800**
	- NZTA-Managed Costs	**0**	**0**	**0**
	- Consent Monitoring Fees	**0**	**0**	**0**
	Sub Total Base MSQA	**560,000**	**112,000**	**184,800**
	Physical Works			
D1	Environmental Compliance	350,000	70,000	115,500
D2	Earthworks	1,000,000	300,000	500,000
D3	Ground Improvements	25,500	5,100	8,400
D4	Drainage	1,082,000	216,400	357,100
D5	Pavement and Surfacing	2,962,500	592,500	977,600
D6	Bridges / Structures	0	0	0
D7	Retaining Walls	0	0	0
D8	Traffic Services	231,500	46,300	76,400
D9	Service Relocations	1,737,500	347,500	573,400
D10	Landscaping	580,000	116,000	191,400
D11	Traffic Management and Temporary Works	1,500,000	300,000	495,000
D12	Preliminary and General	1,000,000	200,000	330,000
D13	Extraordinary Construction Costs	0	0	0
	Sub Total Base Physical Works	**10,469,000**	**2,193,800**	**3,624,800**
D	**Total Construction & MSQA**	**11,029,000**	**2,305,800**	**3,809,600**
E	**Project Base Estimate** (A+B+C+D)	**12,859,000**		
F	**Contingency** (Assessed / Analysed) (A+B+C+D)		**2,671,800**	
G	**Project Expected Estimate** (E+F)		**15,530,800**	
	Project Property Cost Expected Estimate		**1,188,000**	
	Investigation and Reporting Expected Estimate		**336,000**	
	Design and Project Documentation Expected Estimate		**672,000**	
	Construction Expected Estimate		**13,334,800**	
H	**Funding Risk** (Assessed / Analysed) (A+B+C+D)			**4,413,500**
I	**95th Percentile Project Estimate** (G+H)			**19,944,300**
	Project Property Cost 95th Percentile Estimate			**1,514,700**
	Investigation and Reporting 95th Percentile Estimate			**428,400**
	Design and Project Documentation 95th Percentile Estimate			**856,800**
	Construction 95th Percentile Estimate			**17,144,400**

Base Date of Estimate	**8 Nov 2012**	**Cost Index**
Estimate prepared by:	**Jamie Povall**	**Signed**
Estimate internal peer review by:	**Marten Oppenhuis**	**Signed**
Estimate external peer review by:		**Signed**
Estimate approved by NZTA Project Manager:		**Signed**

Note: (1) These estimates are exclusive of escalation and GST.

Project Estimate - Form A

Project Name: Otaki to Levin PFR Study - PFR 5 (SH1/57 Arapaepae), Option 5-3a

FE

Feasibility Estimate

Item	Description	Base Estimate	Contingency	Funding Risk
A	**Nett Project Property Cost**	**1,820,000**	**364,000**	**600,600**
	Investigation and Reporting			
	- Consultancy Fees	**940,000**	**188,000**	**310,200**
	- NZTA-Managed Costs	**0**	**0**	**0**
B	**Total Investigation and Reporting**	**940,000**	**188,000**	**310,200**
	Design and Project Documentation			
	- Consultancy Fees	**1,880,000**	**376,000**	**620,400**
	- NZTA-Managed Costs	**0**	**0**	**0**
C	**Total Design and Project Documentation**	**1,880,000**	**376,000**	**620,400**
	Construction			
	MSQA			
	- Consultancy Fees	**1,880,000**	**376,000**	**620,400**
	- NZTA-Managed Costs	**0**	**0**	**0**
	- Consent Monitoring Fees	**0**	**0**	**0**
	Sub Total Base MSQA	**1,880,000**	**376,000**	**620,400**
	Physical Works			
D1	Environmental Compliance	1,200,000	240,000	396,000
D2	Earthworks	4,050,000	1,215,000	2,025,000
D3	Ground Improvements	360,000	72,000	118,800
D4	Drainage	2,231,450	446,300	736,400
D5	Pavement and Surfacing	4,267,500	853,500	1,408,300
D6	Bridges / Structures	12,000,000	2,400,000	3,960,000
D7	Retaining Walls	755,000	151,000	249,200
D8	Traffic Services	809,250	161,900	267,100
D9	Service Relocations	1,687,500	337,500	556,900
D10	Landscaping	271,000	54,200	89,400
D11	Traffic Management and Temporary Works	1,500,000	300,000	495,000
D12	Preliminary and General	3,000,000	600,000	990,000
D13	Extraordinary Construction Costs	0	0	0
	Sub Total Base Physical Works	**32,131,700**	**6,831,400**	**11,292,100**
D	**Total Construction & MSQA**	**34,011,700**	**7,207,400**	**11,912,500**
E	**Project Base Estimate (A+B+C+D)**	**38,651,700**		
F	**Contingency** (Assessed / Analysed) **(A+B+C+D)**		**8,135,400**	
G	**Project Expected Estimate (E+F)**		**46,787,100**	
	Project Property Cost Expected Estimate		**2,184,000**	
	Investigation and Reporting Expected Estimate		**1,128,000**	
	Design and Project Documentation Expected Estimate		**2,256,000**	
	Construction Expected Estimate		**41,219,100**	
H	**Funding Risk** (Assessed / Analysed) **(A+B+C+D)**			**13,443,700**
I	**95th Percentile Project Estimate (G+H)**			**60,230,800**
	Project Property Cost 95th Percentile Estimate			**2,784,600**
	Investigation and Reporting 95th Percentile Estimate			**1,438,200**
	Design and Project Documentation 95th Percentile Estimate			**2,876,400**
	Construction 95th Percentile Estimate			**53,131,600**

Base Date of Estimate	**8 Nov 2012**	**Cost Index**
Estimate prepared by:	**Jamie Povall**	**Signed**
Estimate internal peer review by:	**Marten Oppenhuis**	**Signed**
Estimate external peer review by:		**Signed**
Estimate approved by NZTA Project Manager:		**Signed**

Note: (1) These estimates are exclusive of escalation and GST.

Project Estimate - Form A

Project Name: Otaki to Levin PFR Study - PFR 5 (SH1/57 Arapaepae), Option 5-4a

FE

Feasibility Estimate

Item	Description	Base Estimate	Contingency	Funding Risk
A	**Nett Project Property Cost**	**8,800,000**	**1,760,000**	**2,904,000**
	Investigation and Reporting			
	- Consultancy Fees	**1,080,000**	**216,000**	**356,400**
	- NZTA-Managed Costs	**0**	**0**	**0**
B	**Total Investigation and Reporting**	**1,080,000**	**216,000**	**356,400**
	Design and Project Documentation			
	- Consultancy Fees	**2,160,000**	**432,000**	**712,800**
	- NZTA-Managed Costs	**0**	**0**	**0**
C	**Total Design and Project Documentation**	**2,160,000**	**432,000**	**712,800**
	Construction			
	MSQA			
	- Consultancy Fees	**2,160,000**	**432,000**	**712,800**
	- NZTA-Managed Costs	**0**	**0**	**0**
	- Consent Monitoring Fees	**0**	**0**	**0**
	Sub Total Base MSQA	**2,160,000**	**432,000**	**712,800**
	Physical Works			
D1	Environmental Compliance	1,000,000	200,000	330,000
D2	Earthworks	4,780,000	1,434,000	2,390,000
D3	Ground Improvments	337,500	67,500	111,400
D4	Drainage	2,293,000	458,600	756,700
D5	Pavement and Surfacing	5,684,500	1,136,900	1,875,900
D6	Bridges / Structures	4,900,000	980,000	1,617,000
D7	Retaining Walls	330,000	66,000	108,900
D8	Traffic Services	1,101,000	220,200	363,300
D9	Service Relocations	1,687,500	337,500	556,900
D10	Landscaping	580,000	116,000	191,400
D11	Traffic Management and Temporary Works	1,500,000	300,000	495,000
D12	Preliminary and General	2,750,000	550,000	907,500
D13	Extraordinary Construction Costs	0	0	0
	Sub Total Base Physical Works	**26,943,500**	**5,866,700**	**9,704,000**
D	**Total Construction & MSQA**	**29,103,500**	**6,298,700**	**10,416,800**
E	**Project Base Estimate** (A+B+C+D)	**41,143,500**		
F	**Contingency** (Assessed / Analysed) (A+B+C+D)		**8,706,700**	
G	**Project Expected Estimate** (E+F)		**49,850,200**	
	Project Property Cost Expected Estimate		**10,560,000**	
	Investigation and Reporting Expected Estimate		**1,296,000**	
	Design and Project Documentation Expected Estimate		**2,592,000**	
	Construction Expected Estimate		**35,402,200**	
H	**Funding Risk** (Assessed / Analysed) (A+B+C+D)			**14,390,000**
I	**95th Percentile Project Estimate** (G+H)			**64,240,200**
	Project Property Cost 95th Percentile Estimate			**13,464,000**
	Investigation and Reporting 95th Percentile Estimate			**1,652,400**
	Design and Project Documentation 95th Percentile Estimate			**3,304,800**
	Construction 95th Percentile Estimate			**45,819,000**

Base Date of Estimate	**8 Nov 2012**	**Cost Index**
Estimate prepared by:	**Jamie Povall**	**Signed**
Estimate internal peer review by:	**Marten Oppenhuis**	**Signed**
Estimate external peer review by:		**Signed**
Estimate approved by NZTA Project Manager:		**Signed**

Note: (1) These estimates are exclusive of escalation and GST.

Appendix F Economic Analysis Worksheets

SH1N / SH57 Otaki to Levin - PFR Economic Evaluation
Cost - Benefit Analysis of the Options

Worksheet 3

Project Options	Do Minimum: Continued Maintenance	Option 5-1a: Grade Separated Right and Left Turn	Option 5-1b: Grade Separated Right Turn	Option 5-2: Roundabout	Option 5-3a: Bifurcation North of Ohau	Option 5-4a: Bifurcation and Link to Ohau Straight	Option 5-4b: Bifurcation and New Eastern River Crossing		Option 5-1a: Grade Separated Right and Left Turn	Option 5-1b: Grade Separated Right Turn	Option 5-2: Roundabout	Option 5-3a: Bifurcation North of Ohau	Option 5-4a: Bifurcation and Link to Ohau Straight	Option 5-4b: Bifurcation and New Eastern River Crossing
Costs									Net Costs of the Project Options					
Capital Costs	0	36,908,108	0	14,324,179	46,841,007	53,491,072	0		36,908,108		14,324,179	46,841,007	53,491,072	
Maintenance Costs	875,369	569,585	0	550,980	606,615	649,082	0		(305,785)		(324,389)	(268,754)	(226,287)	
Total Costs									**36,602,324**		**13,999,790**	**46,572,252**	**53,264,785**	
Benefits									Net Benefits of the Project Options					
Travel Time Costs	139,996,392	132,020,282	0	143,034,481	132,973,810	124,944,311	0		7,976,111		(3,038,089)	7,022,582	15,052,081	
Congestion Costs														
Vehicle Operating Costs	195,690,300	155,384,150	0	191,320,642	159,352,612	152,361,361	0		40,306,149		4,369,657	36,337,688	43,328,938	
Crash Costs	37,228,793	21,689,650	0	25,730,748	22,015,901	21,306,136	0		15,539,143		11,498,046	15,212,892	15,922,657	
Seal Ext / Passing Lane														
Carbon Dioxide	8,431,413	7,179,078	0	8,431,013	7,365,168	7,038,801	0		1,252,335		400	1,066,245	1,392,612	
Tangible Benefits									**65,073,738**		**12,830,014**	**59,639,407**	**75,696,289**	
TANGIBLE BENEFIT COST RATIO (BCR)									**1.78**		**0.92**	**1.28**	**1.42**	
Ranking BC Ratio														
Intangible Benefits														

Incremental Cost-Benefit Analysis of Project Options

Worksheet 4

Target incremental BCR (A12.4) 1.0

Step	Base Option for Comparison			Next Higher Cost Option				Incremental Analysis			
	Option	Costs	Benefits	Option	Costs	Benefits		Incremental Costs	Incremental Benefits	Incremental BC Ratio	Base Option for Next Step
1	Option 5-2	13,999,790	12,830,014	Option 5-1a	36,602,324	65,073,738		22,602,534	52,243,724	2.31	Option 5-1a
2	Option 5-1a	36,602,324	65,073,738	Option 5-3a	46,572,252	59,639,407		9,969,929	(5,434,331)	(0.55)	Option 5-1a
3	Option 5-1a	36,602,324	65,073,738	Option 5-4a	53,264,785	75,696,289		16,662,461	10,622,551	0.64	Option 5-1a
4	Option 5-1a	36,602,324	65,073,738								
5											
6											
7											

Preferred Project Option: **Option 5-1a**
Other Factors: