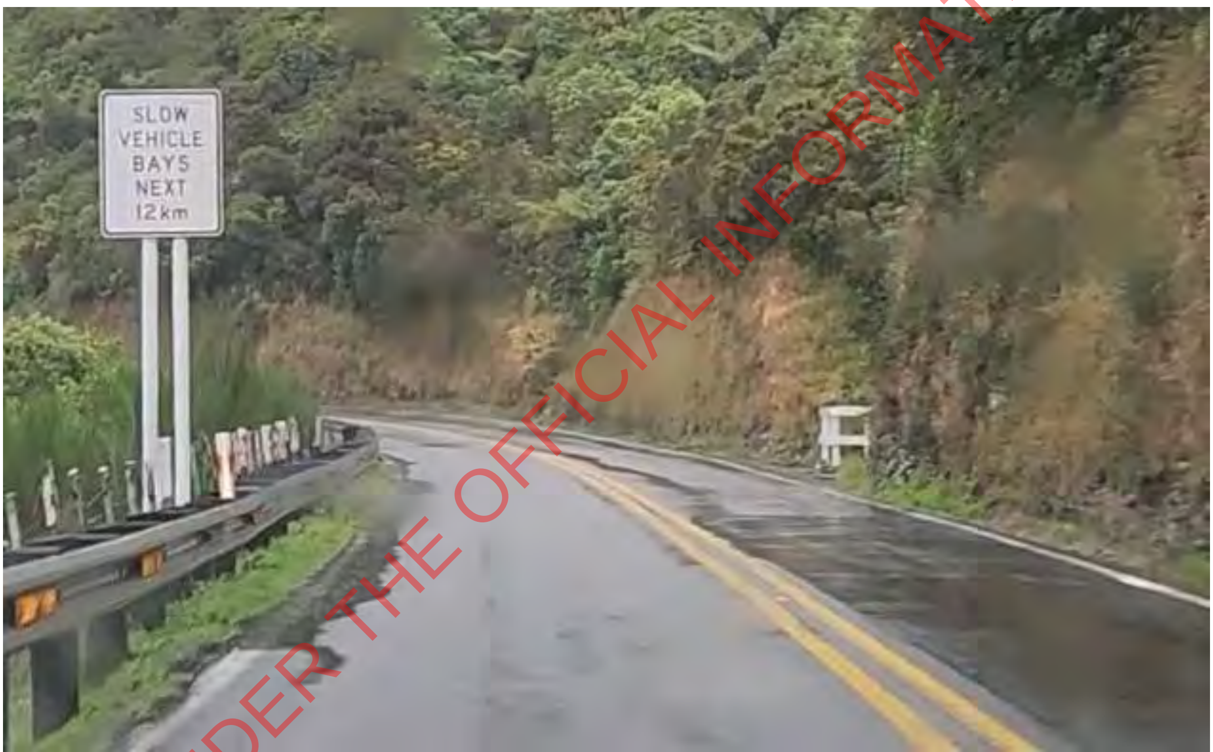
Project Number: 5-C4708.00

SH2 Remutaka Slow Vehicle Bays

Post Construction Safe System Audit

14 June 2024

CONFIDENTIAL



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Document History and Status

Revision	Date	Author	Reviewed by	Approved by	Status
0	22/05/2024	section 9(2)(a)			Interim Draft
1	14/06/2024			section 9(2)(a)	Final

Revision Details

Revision	Details
0	Interim Draft Safe System Audit.
1	Safe System Assessment inclusion and final issue

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Disclaimers and Limitations

This report ('**Report**') has been prepared by WSP exclusively for New Zealand Transport Agency ('**Client**') in relation to Safe System Audit of the SH2 Remutaka Slow Vehicle Bays ('**Purpose**') and in accordance with the offer of service dated 23/05/2023. The findings in this Report are based on and are subject to the assumptions specified in the Report. WSP accepts no liability whatsoever for any reliance on or use of this Report, in whole or in part, for any use or purpose other than the Purpose or any use or reliance on the Report by any third party.

In preparing the Report, WSP has relied upon data, surveys, analyses, designs, plans and other information ('**Client Data'**) provided by or on behalf of the Client. Except as otherwise stated in the Report, WSP has not verified the accuracy or completeness of the Client Data. To the extent that the statements, opinions, facts, information, conclusions and/or recommendations in this Report are based in whole or part on the Client Data, those conclusions are contingent upon the accuracy and completeness of the Client Data. WSP will not be liable in relation to incorrect conclusions or findings in the Report should any Client Data be incorrect or have been concealed, withheld, misrepresented or otherwise not fully disclosed to WSP.

The findings and recommendations in the Report are based on an examination of the available relevant plans, the specified road and its environs, and the opinions of the Safe System Audit Team. However, it must be recognised that eliminating safety concerns cannot be guaranteed since no road can be regarded as absolutely safe and no warranty is implied that all safety issues have been identified in this report. Safe System audits do not constitute a design review nor an assessment of standards with respect to engineering or planning documents.

Readers are urged to seek specific technical advice on matters raised and not rely solely on the report.

While every effort has been made to ensure the accuracy of the report, it is made available on the basis that anyone relying on it does so at their own risk without any liability to the Safe System Audit Team or their organisations.

1 Safe System Auditing for Transport Projects

A Safe System audit is an independent review of a future transport project to identify any safety concerns that may affect the safety performance and alignment to a Safe System. The audit team considers the safety of all road users and qualitatively reports on road safety issues or opportunities for safety improvement.

A Safe System audit is therefore a formal examination of a transport project, or any type of project which affects road users (including cyclists, pedestrians, mobility impaired etc), carried out by an independent competent team who identify and document Safe System alignment and road safety concerns.

A Safe System audit is intended to help deliver a safe road system and is not a review of compliance with standards.

1.1 Safe System Audit Procedure

The primary objective of a Safe System audit is to deliver a project that achieves an outcome consistent with the Safe System approach, that is, minimisation of death and serious injury. The Safe System audit is a safety review used to identify all areas of a project that are inconsistent with a safe system and bring those concerns to the attention of the client in order that the client can make a value judgement as to appropriate action(s) based on the risk guidance provided by the safety audit team.

The key objective of a Safe System audit is summarised as:

> *To deliver completed projects that contribute towards a Safe System by identifying and ranking potential safety concerns for all road users and others affected by a transport project*.

A Safe System audit should be undertaken at project milestones such as:

- Concept Stage (part of Business Case);
- Scheme or Preliminary Design Stage (part of Pre-Implementation);
- Detailed Design Stage (Pre-implementation / Implementation); and
- Pre-Opening / Post-Construction Stage (Implementation / Post-Implementation).

A Safe System audit is not intended as a technical or financial audit and does not substitute for a design check on standards or guidelines.

Any recommended treatment of an identified safety concern is intended to be indicative only, and to focus the design team on the type of improvements that might be appropriate. It is not intended to be prescriptive and other ways of improving the road safety or operational problems identified should also be considered.

In accordance with the procedures set down in the *"Waka Kotahi NZ Transport Agency Safe System Audit Guidelines"* the audit report should be submitted to the client who will instruct the design team to respond. The design team should consider the report and comment to the client on each of any concerns identified, including their cost implications where appropriate, and make a recommendation to either accept or reject the audit report recommendation.

For each audit team recommendation that is accepted, the client shall make the final decision and brief the design team to make the necessary changes and/or additions. As a result of this instruction the design team shall action the approved amendments. The client may involve a safety engineer to provide commentary to aid with the decision.

Decision tracking is an important part of the Safe System audit process. A decision tracking table is embedded into the report format at the end of each set of recommendations to be completed by the design team, safety engineer and client for each issue documenting the design team's response, client decision and action taken.

A copy of the report including the design team's response to the client and the client's decision on each recommendation shall be given to the Safe System audit team leader as part of the important feedback loop. The Safe System audit team leader will disseminate this to team members.

1.2 Safe System Pillars

The Safe System approach seeks to ensure that no road user is subjected to kinetic energy exchange in a crash that will result in death or serious injury. There is a shared responsibility for safe travel outcomes between system designers (road authorities, vehicle manufactures, road designers etc.) and road users. There are four Safe System pillars: safe vehicles, safe speeds, safe roads, and safe road users. Post-crash response is another element that is often recognised as the fifth pillar. All parts of the system must be considered and strengthened so that road safety outcomes are maximised and to ensure that road users are adequately protected even if one part fails. The Safe System approach aims to create a road system that is forgiving of mistakes.
Safe System Assessment (SSA) is concerned mainly with the safer roads and safer speeds pillars. A SSA is used to examine road project proposals and aims to identify infrastructure and speed related factors that are likely to contribute to a higher risk of fatal and serious injuries occurring. The SSA seeks to identify design or scope changes that will improve the alignment of the project with Safe System principles.

Figure 1: Safe System Pillars

1.3 Safe System Impact Speeds

The impact speed in a collision is a significant factor that affects the probability of a person being killed or seriously injured in a crash. Safe System impact speeds are speeds below which the chances of survival are high, and the likelihood of serious injury is low.
Figure is a guide to Safe System impact speeds for common crash types. It should be noted that the angle of impact of a collision is also a factor that affects the severity of a crash. As far as is practically possible, infrastructure should be designed, and travel speeds managed so that the impact speeds when a crash occurs are below the thresholds show in Figure .

Figure 2: Safe System Impact Speeds

1.4 Report Format

The potential road safety problems identified have been ranked as follows:

The expected crash frequency is qualitatively assessed on the basis of expected exposure (how many road users will be exposed to a safety issue) and the likelihood of a crash resulting from the presence of the issue. The severity of a crash outcome is qualitatively assessed on the basis of factors such as expected speeds, type of collision, and type of vehicle involved.

Reference to historic crash rates or other research for similar elements of projects, or projects, have been drawn on where appropriate to assist in understanding the likely crash types, frequency and likely severity that may result from a particular concern.

The frequency and severity ratings are used together to develop a combined qualitative risk ranking for each safety issue using the Safety concern risk rating matrix below. The qualitative assessment requires professional judgement and a wide range of experience in projects of all sizes and locations.

Table 1: Safety concern risk rating matrix.

		Severity outcome				
		Non-injury	**Minor**		**Serious**	**Fatal**
		Property damage only (PDO)	Injury[1]	**Safe System injury threshold**	Injury[2]	A death[3]
Probability of a crash	**Very likely** (One per year)	Minor	Moderate		Serious	Serious
	Likely (1 to 3 years)	Minor	Moderate		Serious	Serious
	Unlikely (3 to 7 years)	Minor	Minor		Significant	Serious
	Very unlikely (7 years +)	Minor	Minor		Significant	Significant

[1] Injury which is not 'serious' but requires first aid, or which causes discomfort or pain to the person injured.
[2] Injury (fracture, concussion, severe cuts or other injury) requiring medical treatment or removal to and retention in hospital.
[3] A death occurring as the result of injuries sustained in a road crash within 30 days of the crash.

2 Safe System Audit Details

2.1 Type of Audit

This audit is a Safe System Audit for the post construction of Slow Vehicle Bays on SH2 Remutaka as part of the Speed & Infrastructure Programme Upper Hutt to Featherston Safety Improvements. The aim of the audit is to identify safety concerns for all road users and determine the project's alignment to a safe system.

2.2 Audit Team

The Safe System Audit Team (SSAT) is made up of the following members:

- section 9(2)(a) WSP, Safety Audit Team Leader
- section 9(2)(a), WSP, Safety Audit Team Member
- section 9(2)(a), WSP, Safety Audit Team Member
- section 9(2)(a), WSP, Safety Audit Team Member – Safe System Assessments
- section 9(2)(a) WTA, Independent Observer

2.3 Meetings and Site Inspections

The Safe System Audit Team conducted a site visit on Tuesday 21st May 2024 at 1pm. No night time inspection took place.

Following the delivery of the interim draft safe system audit report, section 9(2)(a) became involved in the re-design of the project. Consequently section 9(2)(a) was replaced by section 9(2)(a) for the Safe System Assessments.

3 Project Description

3.1 Project Background and Objective

The previous passing lanes were inconsistent with the proposed 60 km/h speed limit for SH2 Remutaka. Previous passing lanes were short and substandard. The replacement of existing passing facilities on SH2 Remutaka with Slow Vehicle Bays provides consistency to users. The hatched areas on the entry and exit of the Slow Vehicle Bays seeks to reduce conflict between passing and passed road users.

3.2 Existing Conditions and Context

SH2 Remutaka is a steep, tortuous, narrow road with 7,064 vpd[1] (approximately 460 vehicle vehicles per day) providing a key link between the Hutt Valley and the Wairarapa.

Land use

Surrounding land on SH2 Remutaka is mostly mountainous undeveloped land. There are infrequent accesses along the route, with three "intersection" style accesses of low volumes.

Speed

The posted speed limit on SH2 Remutaka is 100 km/h.

There is range of user speeds on SH2 Remutaka which are impacted by traffic composition, horizontal curvature, and gradient. Trucks typically have a lower average speed than light vehicles, and motorcyclists typically have higher average speeds than light vehicles.

The majority of road users from the 30th to 90th percentile are travelling in a narrow speed range between 47 and 60 km/h. The slowest 30% of road users show greater variation, travelling between less than 35 and 47 km/h, and the fastest 10% of road users are travelling at speeds of 60 km/h and greater. There does not appear to be a significant difference in travel speeds between northbound and southbound directions.

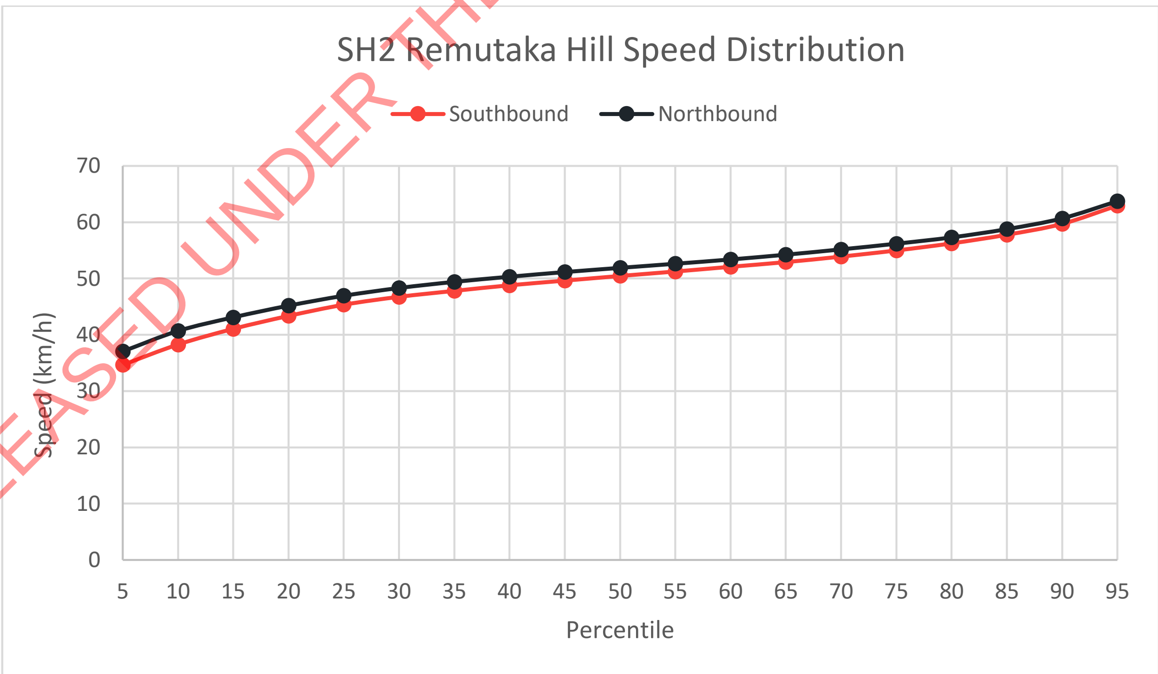


Figure 3: SH2 Remutaka Hill speed distribution (data obtained from TomTom, 2023).

[1] Mobile Road.

Road Users

In addition to heavy and light vehicles, SH2 Remutaka is a popular route for recreational motorcyclists. Motorcyclists have been estimated to be 1% of all users within this audit, motorcyclists disproportionately feature in fatal and serious injury crash statistics for SH2 Remutaka, see section 3.4.

There was a range of road user behaviours observed interacting with the slow vehicle bays:

- Professional HCV drivers appeared to use the full length including entry and exit hatching.
- Light vehicle behaviour was more diverse;
  - Some entered over the entry hatching,
  - Some exited over the terminal hatching,
  - Others entered and exited over the continuity line marking,
  - Some users were observed in the lane with no nearby vehicles.

3.3 Implemented Works

There have been sign and line marking changes on SH2 Remutaka in three themes; route signs, stopping bay signs, and passing lane signs and markings.

- Route signs; existing "High Risk Motorcycle Route" signs removed in advance of the section. Existing W12-2.4 sign (reverse curve sign) replaced with gated W12-3.1 (curve sign supplementary – next 15km). Passing lane ahead signs also removed.
- Stopping bay signs; "Stopping Bay Ahead" and "Stopping Bay" signs removed from various locations on the route.
- Passing lane signs and markings have been replaced with slow vehicle bay signs and markings; removing passing lane related signs and installing slow vehicle bay ahead and entry signs, removing merge ahead signs and replacing with merge signs at the merge, providing an entry hatched area continuity line the full length of the slow vehicle bay and exit hatched area. The "active" lane within the slow vehicle bays is shorter than the previous passing lanes.
- An additional slow vehicle bay is provided in the Wairarapa-bound (decreasing) direction at RS921-RP4.2.

3.4 Crash History

Waka Kotahi Crash Analysis System (CAS) has records of 205 crashes within the full project extent (including sign changes), for the five years prior to 2023 (inclusive). There is potential that previous crashes occurred have not been reported to police and therefore have not been included in CAS. It should also be noted that crash data for non-injury crashes may take up to 7 months to be available in CAS upon the receipt of a traffic crash report.

Of the 205 crashes recorded, four resulted in fatalities, 14 resulted in serious injury, 49 resulted in minor injury, and 138 were non-injury crashes.

Loss of control on bends was by far the dominant crash type, with 147 crashes over the 5-year period. A full breakdown of crashes by type and severity is presented in Table 2.

Table 2: Breakdown of crashes from 2019-2023 by type and severity.

Crash Type	Fatal Crash	Serious Crash	Minor Crash	Non-Injury Crash	Total
Lost Control Bend	1	8	39	99	147

Head On Crash	3	4	3	12	22
Overtaking			2	14	16
Rear End Crash			3	3	6
Misc				4	4
Obstruction		1	2		3
Lost Control/Straight Rd				2	2
Manoeuvring				2	2
One Turns Right		1		1	2
Other Ped				1	1
Total	**4**	**14**	**49**	**138**	**205**

Table 3 below shows fatal and serious injury crashes by vehicle type and movement considering only the project extent where passing lanes were replaced with slow vehicle bays (including between slow vehicle bays). Vehicle type is simplified to Trucks (truck, HPMV, bus), Motorcycle (motorcycle, mopeds), Truck & Motorcycle, and Neither (including all other users). There are fewer crashes in Table 3 than Table 2 because of the shorter extent.

Motorcycles were involved in three and Trucks involved in one out of the eight lost control bend fatal and serious injury crashes. Motorcycles were involved in three and Trucks involved in two of the six head-on fatal and serious injury crashes.

Other road users were only solely involved in six of the fifteen fatal and serious injury crashes.
Table 3: Breakdown of fatal and severe crashes by crash and vehicle type.

Crash Type	Fatal Crash	Serious Crash
Lost Control Bend	1 Truck	3 Motorcycles 4 Neither
Head On Crash	1 Truck 1 Motorcycle	1 Motorcycle 1 Both 2 Neither
One Turns Right		1 Motorcycle
Total	**2 Trucks 1 Motorcycle**	**5 Motorcycles 1 Both 6 Neither**

3.5 Documents Provided

The SSAT has been provided with the following drawings of the Post Construction Safe System audit:

- *SNP-A-1080-02-C1300-C1332 Slow Vehicle Bay (Dated:28/02/2024)*
- *SNP-A-1080-02-C1300-C1332 Slow Vehicle 06.05.24 (Dated:06/05/2024)*
- *SNP-A-1080-02-C1300-C1340 Slow Vehicle Bays 21.05.24 (Dated:21/05/2024)*
- *Emails between Clare Cassidy & David Cross dated 20/05/2024 & 21/05/2024*

3.6 Previous Safe System/Road Safety Audit Findings

The SSAT is unaware of any previous Safe System Audit undertaken.

4 Assessment of Safe System Alignment

4.1 Project Design Safe System Assessment Summary

The Safe System Assessment Matrix scores for the existing conditions and the proposed design option is shown in Table 4. The scores for each crash type are shown in Error! Reference source not found. with the detailed assessments presented in Appendix A. The lower the score, the better the alignment with Safe System principles.

Pedestrian crashes are excluded because there are no pedestrian facilities and no adjacent land uses that would necessitate pedestrian movements.

Crash types included in the 'Other' category include passing and merging crashes while travelling in the same direction.

Table 4: Safe System assessment score summary table.

Option	Score	Reduction From Existing
Existing Conditions	148 / 448	-
Design Option	138.25 / 448	6.6%

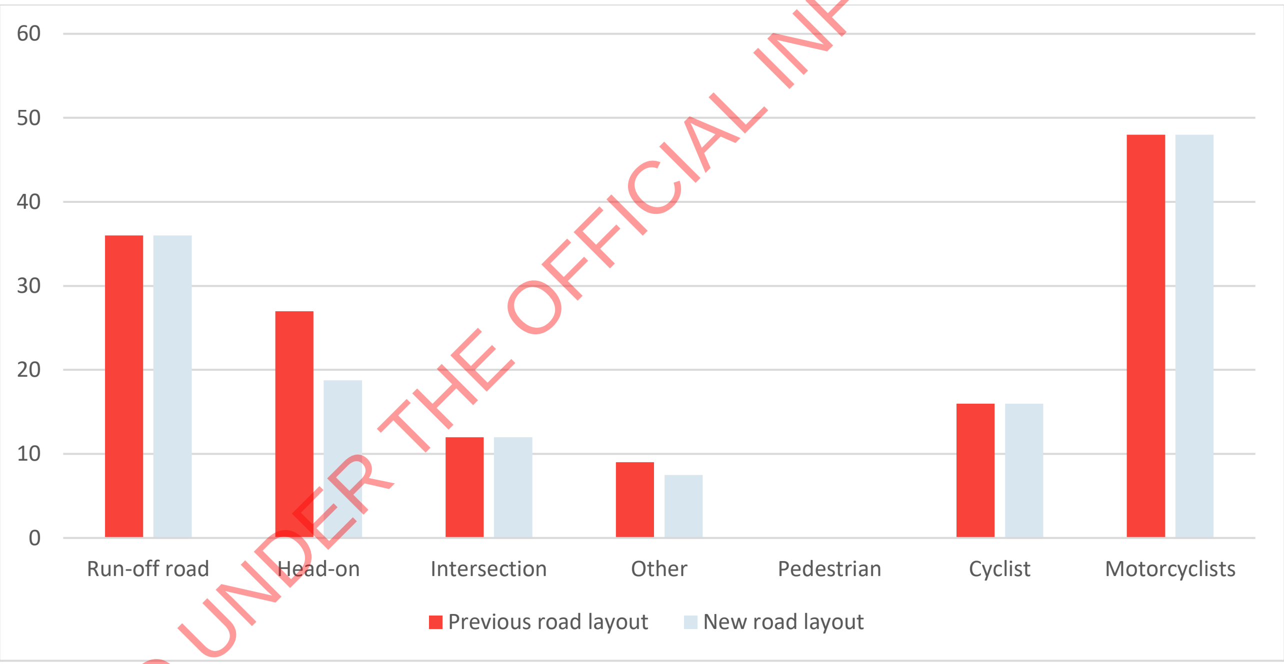


Figure 4: Safe System assessment score summary table.

The Safe System Assessment shows a slight reduction in the Safe System score for the implemented road layout, due to decreased crash risk scores for head-on crashes and overtaking/merging crashes. This is due to the expectation of an overall reduction in travel speeds following the replacement of passing lanes with Slow Vehicle Bays (SVB)s.

However, the expected reduction is small and may be tempered by increased driver frustration at the perception that slow vehicles do not use the SVBs. This may lead to dangerous manoeuvres such as undertaking at a SVB or overtaking with limited forward visibility.

Within the scoring of Head-on and Other crashes, we have assumed that there would be a reduction in vehicle speeds through reduced passing opportunities with the conversion of passing lanes to slow vehicle bays. This reduction in speed has greater positive impacts on the likelihood of crashes than other factors which increase likelihood.

Motorcycle crash risk on SH2 Remutaka is very high as shown by the crash history. Increases to likelihood of motorcycle crashes through increased rider frustration would be negligible compared to the existing risk.

It is unclear why Stopping Bay signage has been removed, and whether this was necessary. Stopping Bays may be more appropriate where there is insufficient length for an SVB. It doesn't affect the SSA score but clarification would be welcome.

4.2 Treatments to Improve Safe System Alignment

Table 5 and Table 6 list treatments that will improve the Safe System alignment of the project. **Primary treatments** are those measures that have the potential to eliminate or come close to eliminating the risk of fatal and serious injury (FSI) crashes. Primary treatments such as median barriers are not considered practical in this location due to its winding and mountainous nature.

Supporting treatments are effective in reducing the risk of FSI crashes but not to the extent of a primary treatment (i.e., there is a residual moderate or significant FSI crash risk). Implementation of a primary treatment should be given priority over a supporting treatment that may be targeting a similar crash risk.

The most effective treatment to reduce crash risk on the SH2 Remutaka road is to reduce and enforce the speed limit to a safe and appropriate speed. This would reduce the risk for all crash types.

Table 5: Primary Treatments.

Treatments for consideration	Project response
• No practical primary treatments.	

Table 6: Supporting Treatments.

Treatments for consideration	Project response
• Permanent reduction in posted speed limit to 60 km/h to algin with existing light vehicle operating speeds. • Provide clarification regarding the reasons for removal of Stopping Bays. Consider re-instating Stopping Bay signage where it has been removed and replaced with hatched marking, and where there is insufficient length for a SVB. • Improvements to the SVBs and the entry and terminal areas. • Treatments to prevent or reduce likelihood of rockfall or slips. • Frequent maintenance to ensure road is clear of debris and maintains a safe, high-friction surface. • Investment in rail corridor to increase freight and passenger volumes moved through the rail network, reducing freight and light vehicle demand on the SH2 Remutaka (being progressed through LNIRIM).	

5 Safety Concerns

5.1 Slow Vehicle Bay Terminal Merge Serious Concern

The Slow Vehicle Bays are marked with a continuity line throughout the length of the lane, with a hatched area on the terminal of the Slow Vehicle Bay (SVB). The current marking layout requires Slow Vehicle Bay users to giveway to passing traffic to re-enter the “through” lane.

Poorly completed merge manoeuvres can result in a number of crash types:

- Rear-end crashes where a SVB user stops in the slow vehicle lane and is struck by another SVB user,
- Merge Crashes where a SVB user strikes or is struck by another user travelling in the same direction but no other impacts,
- Loss of Control crashes where a SVB user strikes or is struck by another user travelling in the same direction or loses control reacting to another road user and then strikes the guardrail or embankment, and
- Head-on crashes where following a collision between two road user or loses control reacting to another road user, one road user crosses the centreline striking a road user travelling in the opposite direction.

The severity of the crashes depends on the sizes and speeds of the road users.

There are a number of factors that contribute to the safety concern.

Visibility to road users approaching from behind
Due to the tortuous nature of SH2 Remutaka, on some slow vehicle bays it is difficult to sight other road users approaching from behind while occupying the Slow Vehicle Bay. Locations where visibility was challenging include:

- Wairarapa-bound, RS931, RP1.5
- Hutt-bound, RS921, RP9.5

Limited visibility occurred on both left hand and right-hand curves. On left hand curves the wing mirror view is either into the hillside or over the cliff rather than over the lane. On right hand curves the roadside topography can obscure visibility. The challenging visibility distracts drivers attention away from the carriageway ahead of them, increasing handling errors or potentially striking an object. Some SVB users may come to a stop to identify a gap in traffic.

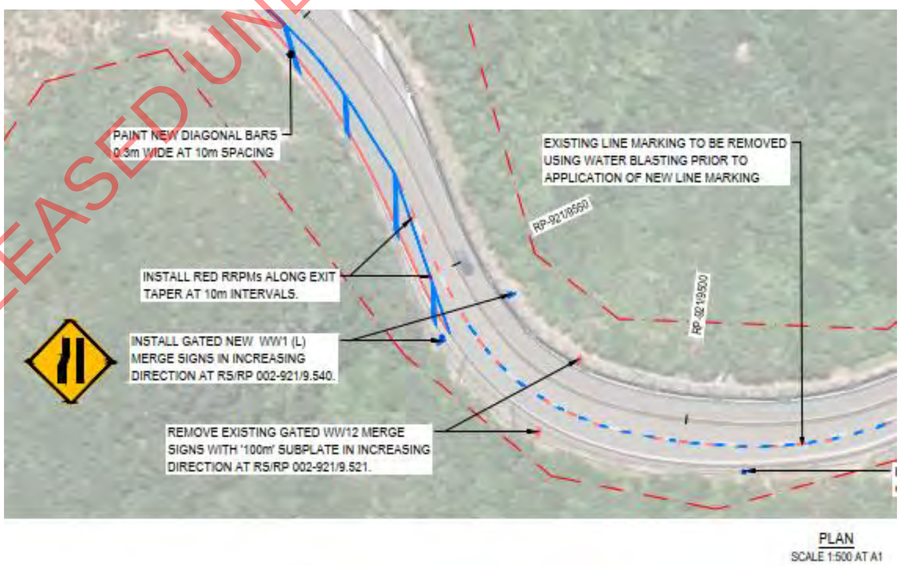


Figure 5: Location of end hatching relative to geometry making returning to the through lane challenging.

End Merge Taper rate and curve geometry

End taper rate and subsequent curve geometry forms a challenging manoeuvre for SBV users, increasing the risk of handling errors resulting in loss of control movements. The SBV users have complicated tightening and reverse curves to negotiate to return to the through lane in most locations.

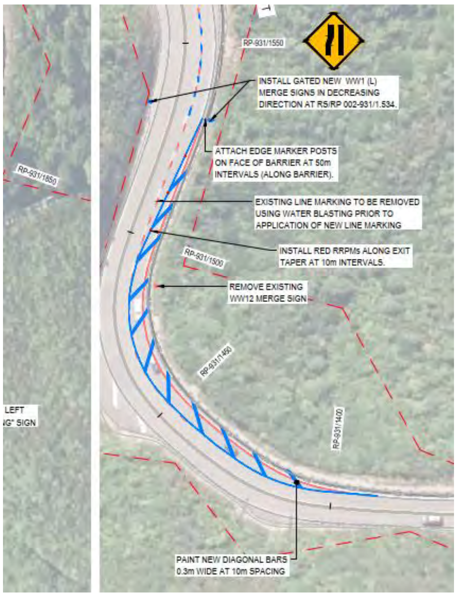


Figure 6: Taper angle and road geometry conflict

Continuity Line marking throughout full length between Hatched areas

The continuity line marking on site is marked throughout the full length of the Slow Vehicle Bay, unlike what is shown on the plans. This reinforces that SBV users need to giveway to through traffic.

Figure 7: Continuity lines marked to end of Slow Vehicle Bay

Recommendation: Consider remarking slow vehicle bay terminal merge(s) to reduce conflict between various road users, particularly; extend short slow vehicle bays, *consider length of taper, and geometry of taper. End continuity line prior to taper as designed*

Probability Rating:	Likely	*Severity Outcome Rating:*	Serious
Design Team Response:	Click here to enter text.		
Safety Engineer:	Click here to enter text.		
Client Decision:	Click here to enter text.		
Action Taken:	Click here to enter text.		

5.2 Slow Vehicle Bay Entry taper — Moderate Concern

While low speeds mitigate crash likelihood and severity, this becomes more of a vehicle handling issue. Entry over the SVB lane line marking also reduce the effective length of the bay.

Such complicated manoeuvres and highly demanding vehicle handling can result mainly in loss of control and run off road crash types. At low speeds, the severity is low, however, the likelihood is high.

Entry Taper
The Slow Vehicle Bays are marked with a hatched area on the entry tapers. The current marking layout encourages some SVB users to manoeuvre around the hatched area and then enter the SVB lane, in some cases at a sharp angle or tightening horizontal alignment especially around curves. This makes entering the SVB complicated, in regard to vehicle handling, as the driver tends to require three movements negotiating the curve, tightening into the bay and then another tight reverse curve to position the vehicle into the lane and follow the road alignment.

Entry hatching
If entering over the entry hatching, vehicle handling is simpler typically consisting of a single movement. However, the hatched markings may cause some drivers to refrain entering this area as it is perceived as an area for emergency / wider vehicle turning use.

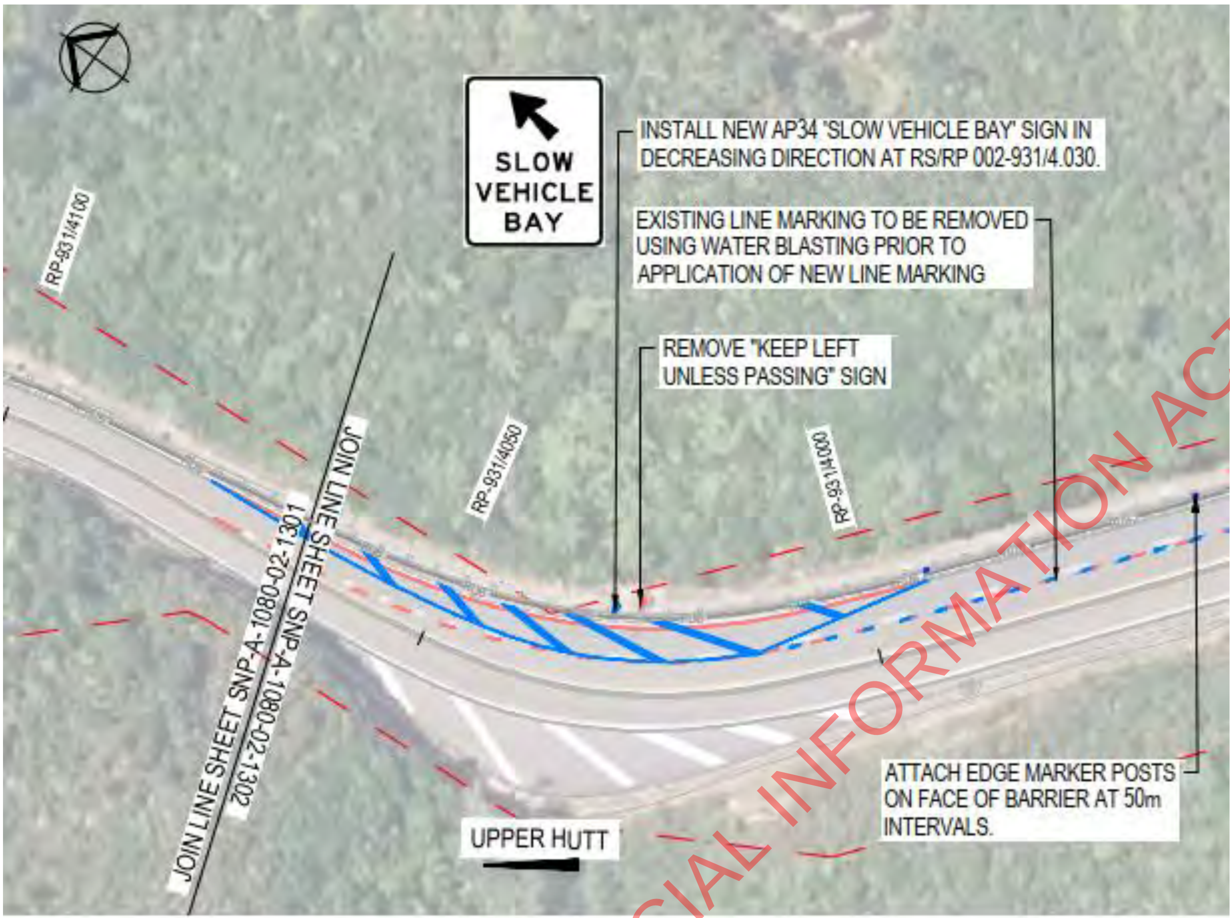


Figure 8: Curve geometry and hatched entry/taper for Slow Vehicle Bay

Recommendation: *Consider removing hatching having taper at the current diverge. If hatching retained, consider shifting the AP34 "Slow Vehicle Bay" sign to the start of the hatched area to encourage direct entry over the hatching to improve entry negotiation.*

Probability Rating:	Likely	*Severity Outcome Rating:*	Minor
Design Team Response:	Click here to enter text.		
Safety Engineer:	Click here to enter text.		
Client Decision:	Click here to enter text.		
Action Taken:	Click here to enter text.		

5.3 Through traffic separation — Significant Concern

Under the previous layout, within the passing lanes, the through traffic lane was on the left-hand side of the carriageway. With a Slow Vehicle Bay, the through traffic lane is in the centre of the carriageway, reducing the offset between the opposing through traffic lanes, increasing the head-on crash risk when road users lose control. SH2 Remutaka has a high number of loss of control crashes.

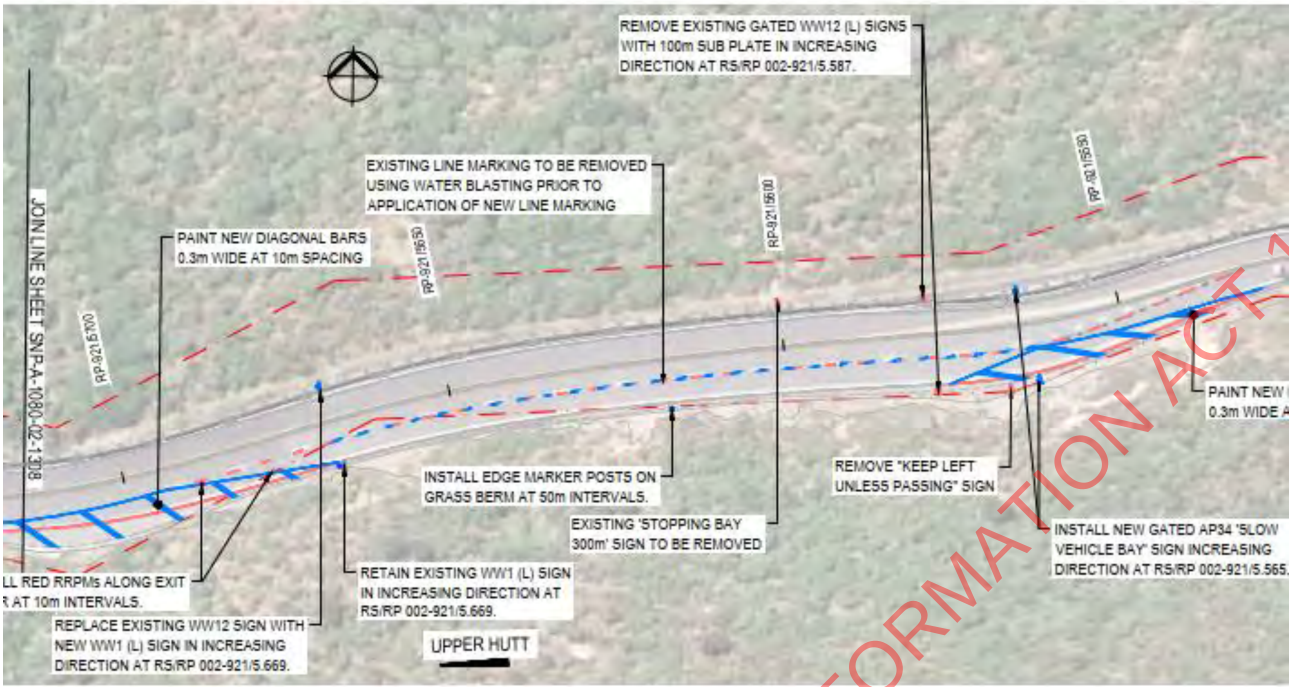


Figure 9: Reduced offset between through traffic lanes.

Recommendation: *Encourage through vehicle movement into left hand lane by diverging from the centre line rather than the edgeline.*

Probability Rating:	Very Unlikely	*Severity Outcome Rating:*	Serious
Design Team Response:	Click here to enter text.		
Safety Engineer:	Click here to enter text.		
Client Decision:	Click here to enter text.		
Action Taken:	Click here to enter text.		

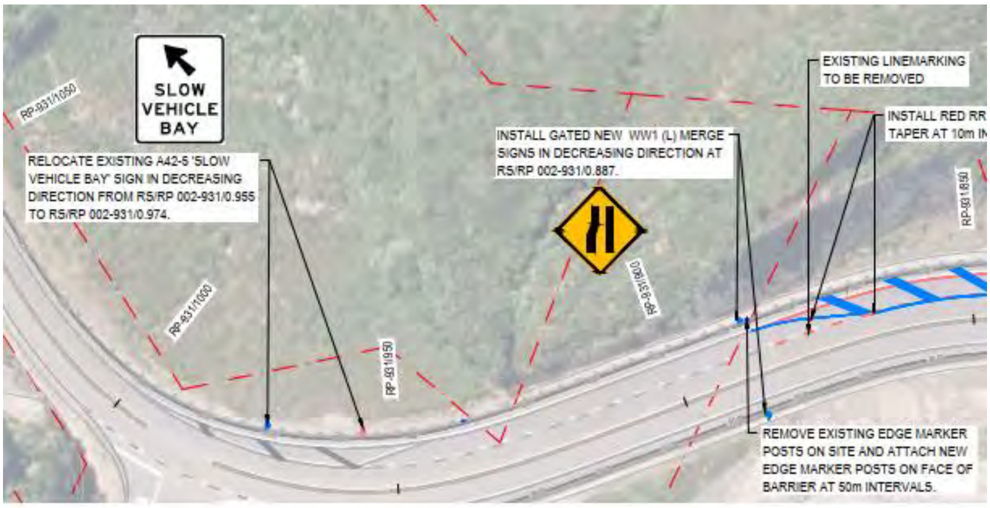
5.4 Slow Vehicle Bay Length — Moderate Concern

Most of the Slow Vehicle Bays have a continuity line length of approximately 150 m to 250 m. However, three are short with continuity line lengths of approximately 100 m or less. Short Slow Vehicle Bays limit the number of vehicles which can be safely passed, unsafe passing manoeuvres increase the head-on crash risk. Locations with short lengths include:

- Wairarapa-bound, RS931, RP0.9
- Hutt-bound, RS921, RP6.5
- Wairarapa-bound, RS921, RP4.2

For short Slow Vehicle Bays the relative potential speed differential, vehicle lengths, and acceleration rates on significant slopes limit the ability of effective Slow Vehicle Bay use. Austroads Guide to Geometric Design[2] refers to MOTSAM Part 1 & Part 2 for lengths (see Figure 11 below).

[2] AGRD03-16, Section 9.6.



PLAN
SCALE 1:500 AT A1

Figure 10: Short Slow Vehicle Bay with ineffective passing length.

Mean Traffic Speed (km/h)	Minimum Length of Slow Vehicle Bay * (excluding entry and exit tapers) (m)
30	60
40	60
50	70
60	80
70	100
80	135
90	175

Table 2.4: RECOMMENDED MINIMUM LENGTHS FOR SLOW VEHICLE BAYS

* *Minimum bay length is based on the assumption that a vehicle will enter a slow vehicle bay travelling at least 8 km/h slower than the mean speed of traffic on that section of road and it will be able to stop, if necessary, within in half the length of the bay while using a deceleration rate not exceeding 3 m/sec².*

Figure 11: MOSTAM Slow Vehicle Bay length guidance.

Recommendation: Carry out speed surveys on entry into all Slow Vehicle Bays to determine if there is adequate length for a safe passing manoeuvre based on vehicle speeds, if not convert into hatched area.

Probability Rating:	Very Unlikely	*Severity Outcome Rating:*	Serious
Design Team Response:	Click here to enter text.		

Safety Engineer:	Click here to enter text.
Client Decision:	Click here to enter text.
Action Taken:	Click here to enter text.

5.5 Advanced sign placement — Moderate Concern

All Slow vehicle bays have an AP32 (Slow Vehicle Bay 300m) signs. For some Slow Vehicle Bays, there are wide hatched areas used as informal stopping areas between the signs and the slow vehicle bays causing confusion for road users. Examples include:

- Wairarapa-bound, RS921, RP4.2
- Hutt-bound, RS921, RP3.35

Due to low operating speeds, 300 m is between 20 and 40 seconds ahead of the slow vehicle bay. Road users are not adequately able to judge the distance travelled over this period and may attempt to use an inappropriate facility for being passed.

Figure 12: Long offset between advanced notification of Slow Vehicle Bay and bay location.

Recommendation: *Consider relocating advanced warning sign to start of hatched area at RP4.35 and RP3.1 to reduce confusion for slow vehicle bays identified above.*

Probability Rating:	Likely	*Severity Outcome Rating:*	Minor
Design Team Response:	Click here to enter text.		
Safety Engineer:	Click here to enter text.		
Client Decision:	Click here to enter text.		
Action Taken:	Click here to enter text.		

5.6 Hatching marking missing — Minor Concern

The Wairarapa-bound Slow Vehicle Bay at RS921 RP4.2 does not have hatched markings on the entry or terminal areas.

Recommendation: Consider marking the hatched markings consistently with other Slow Vehicle Bays

Probability Rating:	Unlikely	*Severity Outcome Rating:*	Minor
Design Team Response:	Click here to enter text.		
Safety Engineer:	Click here to enter text.		
Client Decision:	Click here to enter text.		
Action Taken:	Click here to enter text.		

6 Conclusions

The Safe System Assessment shows that the proposed slow vehicle bays marginally align with the Safe System principles, decreasing the Safe System Assessment Score by 6.6%. However this is dependant on the assumption that converting passing lanes into slow vehicle bays will decrease facility use by slower vehicles, lowering the overall speed profile.

The safe system audit team did not identify any practical primary treatments which can improve the safe system alignment. Reducing the posted speed limit from 100 km/h to 60 km/h would align the posted speed limit to the operating speeds encountered on SH2 Remutaka, this change is expected to significantly reduce fatal and serious crash occurrence.

There is one serious concern, with the terminal taper of the slow vehicle bays.

There is one significant safety concern, with the reduction in through traffic separation. It should be noted that the likelihood of this event occurring is very low due to the unlikelihood of the event and the small proportion of the SH2 Remutaka being slow vehicle bays.

There are three other concerns rated moderate and minor.

The SSAT believes that all the recommendations related to specific concerns if incorporated in the scheme would provide increase alignment with Safe System principles.

7 Safe System Audit Statement

We certify that we have used the available plans and have examined the specified roads and streets to assess the Safe System alignment and identified any safety concerns that could be changed, removed or modified in order to improve road safety outcomes. The safety concerns identified have been noted in this report.

section 9(2)(a)

Signed: .... Date: 14/06/2024

section 9(2)(a)

Road Safety Team Leader, WSP

section 9(2)(a)

Signed: .... Date: 14/06/2024

section 9(2)(a)

Senior Transport Planner, WSP

section 9(2)(a)

Signed: .... Date: 14/06/2024

section 9(2)(a)

Technical Director Transport, WSP

Design Team:	*Name...*	*Position............................*
	Signature....................................	*Date.................................*
Safety Engineer:	*Name...*	*Position............................*
	Signature....................................	*Date.................................*
Project Manager:	*Name...*	*Position............................*
	Signature....................................	*Date.................................*
Action Completed:	*Name...*	*Position............................*
	Signature....................................	*Date.................................*

Project Manager to distribute audit report incorporating decision to design team, Safety Audit Team Leader, Safety Engineer and project file.

Date: ....

Appendix A

Safe System Assessments

Safe System Assessment Matrix

Appendix Table 1: Safe System Assessment - Previous Road Layout

	Run-off road	Head-on	Intersection	Other	Pedestrian	Cyclist	Motorcyclists
Exposure Comments:	Total volume of vehicles (AADT) using the road: 7,064	Total volume of vehicles (AADT) using the road: 7,064	Total volume of vehicles (AADT) entering the intersection: Very low vehicles accessing car parks and forestry road	Total volume of vehicles (AADT) using the road: 7,064	Number of pedestrians: 0	Number of cyclists: Assumed to be 1-10 per day	Number of motorcyclists: Assumed to be 1% of AADT (71 motorcycles)
Exposure Score:	3/4	3/4	1/4	3/4	0/4	1/4	3/4
Likelihood Comments:	Factors that increase the likelihood include: • 100km/h speed limit which some drivers may target despite tortuous nature of road. • Narrow traffic lanes in places, meaning limited room for error. • Tortuous road with many low radius corners. Factors that decrease the likelihood include: • Operating speeds below 60km/h. • Advisory speed signs on bends.	Factors that increase the likelihood include: • 100km/h speed limit which some drivers may target despite tortuous nature of road. • Passing lanes and stopping bays can encourage higher speeds. • Some passing lanes too short to enable enough distance for safe passing. • Tortuous road with many low radius corners. Factors that decrease the likelihood include: • Operating speeds below 60km/h. • Advisory speed signs on bends.	Factors that increase the likelihood include: • 100km/h speed limit which some drivers may target despite tortuous nature of road. • Deceptive operating speeds due to differences in uphill and downhill directions. • Restricted visibility. Factors that decrease the likelihood include: • Operating speeds below 60km/h, therefore more reaction time.	Factors that increase the likelihood include: • 100km/h speed limit which some drivers may target despite tortuous nature of road. • Passing lanes can encourage higher speeds. • Some passing lanes too short to enable enough distance for safe passing. • Some passing lanes have restricted visibility for passed vehicles. Factors that decrease the likelihood include: • Operating speeds below 60km/h	Factors that increase the likelihood include: • N/A. Factors that decrease the likelihood include: • N/A.	Factors that increase the likelihood include: • 100km/h speed limit which some drivers may target despite tortuous nature of road. • Poor visibility around corners. • Narrow traffic lanes, limited room for overtaking in uphill direction. • High downhill cycling speeds on windy road may increase loss-of-control. • Occasional rockfall on to road. • High exposure to weather conditions, particularly wind. Factors that decrease the likelihood include:	Factors that increase the likelihood include: • High speed limit relative to the recommended safe and appropriate speed. • Poor visibility around corners. • Occasional rockfall on to road. • Some parts of road have not been resurfaced for several years. • High exposure to weather conditions, particularly wind. Factors that decrease the likelihood include: • Some parts of road have been resurfaced in last few years. • Crash barriers to prevent run-off road / loss-of-control crashes.

		• ATP along double yellow centre-lines. • Passing lanes offer opportunity for especially slow vehicles to be passed. • Sign posted stopping bays increases slower road users utilisation reducing risky overtaking. • Passing lanes, where they exist, increase width between opposing vehicles.				• Operating speeds lower than speed limit, more time for vehicles to stop. • Alternative touring route for cyclists via Remutaka Rail Trail. • Recreational cyclists most likely at quietest times of the day. • Multiple opportunities to stop on side of road to let vehicles pass.	• Operating speeds lower than speed limit, more time for other vehicles to stop. • High Risk Motorcycle Route warning signs.
Likelihood Score:	4/4	3/4	3/4	3/4	0/4	4/4	4/4
Severity Comments:	Factors that increase the severity include: • 100km/h speed limit which some drivers may target despite tortuous nature of road. • Steep drop-offs on one side and rocky cliff-face on other. Factors that decrease the severity include: • Operating speeds below 60km/h. • Presence of crash barriers on downhill side. • Presence of Wairarapa railway line reduces volume of heavy vehicles than	Factors that increase the severity include: • 100km/h speed limit which some drivers may target despite tortuous nature of road. Factors that decrease the severity include: • Operating speeds below 60km/h. • Presence of Wairarapa railway line reduces volume of heavy vehicles than there might otherwise be.	Factors that increase the severity include: • 100km/h speed limit which some drivers may target despite tortuous nature of road. • Downhill operating speeds likely to be higher. Factors that decrease the severity include: • Operating speeds below 60km/h.	Factors that increase the severity include: • 100km/h speed limit which some drivers may target despite tortuous nature of road. Factors that decrease the severity include: • Operating speeds below 60km/h. • Presence of Wairarapa railway line reduces volume of heavy vehicles than there might otherwise be.	Factors that increase the severity include: • N/A Factors that decrease the severity include: • N/A	Factors that increase the severity include: • 100km/h speed limit which some drivers may target despite tortuous nature of road. • High downhill speeds of cyclists. Factors that decrease the severity include: • Presence of Wairarapa railway line reduces volume of heavy vehicles than there might otherwise be.	Factors that increase the severity include: • High speed limit relative to the recommended safe and appropriate speed. Factors that decrease the severity include: • Presence of Wairarapa railway line reduces volume of heavy vehicles than there might otherwise be.

	there might otherwise be.						
Severity Score:	3/4	3/4	4/4	1/4	0/4	4/4	4/4
Product (multiply scores above for crash type)	36/64	27/64	12/64	9/64	0/64	16/64	48/64
						TOTAL	148/448

Safe System Assessment Matrix

Appendix Table 2: Safe System Assessment – Implemented Road Layout

	Run-off road	Head-on	Intersection	Other	Pedestrian	Cyclist	Motorcyclists
Exposure Comments:	Total volume of vehicles (AADT) using the road: 7,064	Total volume of vehicles (AADT) using the road: 7,064	Total volume of vehicles (AADT) entering the intersection: Very low vehicles accessing car parks and forestry road	Total volume of vehicles (AADT) using the road: 7,064	Number of pedestrians: 0	Number of cyclists: Assumed to be 1-10 per day	Number of motorcyclists: Assumed to be 1% of AADT (71 motorcycles)
Exposure Score:	3/4	3/4	1/4	3/4	0/4	1/4	3/4
Likelihood Comments:	Factors that increase the likelihood include: • 100km/h speed limit which some drivers may target despite tortuous nature of road. • Narrow traffic lanes in places, meaning limited room for error. • Tortuous Road with many low radius corners. Factors that decrease the likelihood include: • Operating speeds below 60km/h. • Advisory speed signs on bends.	Factors that increase the likelihood include: • 100km/h speed limit which some drivers may target despite tortuous nature of road. • ~~Passing lanes can encourage higher speeds.~~ • ~~Some passing lanes~~ Slow Vehicle Bays further reduced in length, too short to enable enough distance for safe passing. • Change from passing lanes to Slow Vehicle Bays means that default through-traffic lane is adjacent to opposing lane. • Potential for increased driver frustration if perception that	Factors that increase the likelihood include: • 100km/h speed limit which some drivers may target despite tortuous nature of road. • Deceptive operating speeds due to differences in uphill and downhill directions. • Restricted visibility. Factors that decrease the likelihood include: • Operating speeds below 60km/h, therefore more reaction time.	Factors that increase the likelihood include: • 100km/h speed limit which some drivers may target despite tortuous nature of road. • Passing opportunities can encourage higher speeds. • ~~Some passing lanes~~ Slow Vehicle Bays further reduced in length, too short to enable enough distance for safe passing. • Removal of Stopping Bay signage may mean slower vehicles less likely to stop for faster vehicles to pass in places that are suitable for stopping. • Potential for increased driver frustration if perception that	Factors that increase the likelihood include: • Factors that decrease the likelihood include: •	Factors that increase the likelihood include: • 100km/h speed limit which some drivers may target despite tortuous nature of road. • Poor visibility around corners. • Narrow traffic lanes, limited room for overtaking in uphill direction. • High downhill cycling speeds on windy road may increase loss-of-control. • Occasional rockfall on to road. • High exposure to weather conditions, particularly wind. Factors that decrease the likelihood include: • Operating speeds lower than speed limit, more time for vehicles to stop.	Factors that increase the likelihood include: • High speed limit relative to the recommended safe and appropriate speed. • Poor visibility around corners. • Occasional rockfall on to road. • Some parts of road have not been resurfaced for several years. • High exposure to weather conditions, particularly wind. • Potential for increased driver frustration if perception that slower vehicles do not use Slow Vehicle Bay, which may lead to dangerous overtaking or undertaking manoeuvres. Factors that decrease the likelihood include:

		slower vehicles do not use Slow Vehicle Bay, which may lead to dangerous overtaking or undertaking manoeuvres. Factors that decrease the likelihood include: • Operating speeds below 60km/h. • Advisory speed signs on bends. • ATP along double yellow centre-lines. • ~~Passing lanes~~ Slow Vehicle Bays offer opportunity for especially slow vehicles to be overtaken. • ~~Sign posted stopping bays increases slower road users utilisation reducing risky overtaking.~~ • Overall reduction in speed at expected at former passing lane locations due to replacement of passing lanes with Slow Vehicle Bays. • ~~Passing lanes, where they exist, increase width between opposing vehicles~~		slower vehicles do not use Slow Vehicle Bay, which may lead to dangerous overtaking or undertaking manoeuvres. Factors that decrease the likelihood include: • Operating speeds below 60km/h • Overall reduction in speed at expected at former passing lane locations due to replacement of passing lanes with Slow Vehicle Bays.		• Alternative touring route for cyclists via Remutaka Rail Trail. • Recreational cyclists most likely at quietest times of the day. • Multiple opportunities to stop on side of road to let vehicles pass.	• Some parts of road have been resurfaced in last few years. • Crash barriers to prevent run-off road / loss-of-control crashes. • Operating speeds lower than speed limit, more time for vehicles to stop. • ~~High Risk Motorcycle Route warning signs.~~
Likelihood Score:	4/4	~~3~~2.5/4	3/4	~~3~~2.5/4	0/4	4/4	4/4

Severity Comments:	Factors that increase the severity include: • 100km/h speed limit which some drivers may target despite tortuous nature of road. • Steep drop-offs on one side and rocky cliff-face on other. Factors that decrease the severity include: • Operating speeds below 60km/h. • Presence of crash barriers on downhill side. Presence of Wairarapa railway line reduces volume of heavy vehicles than there might otherwise be.	Factors that increase the severity include: • 100km/h speed limit which some drivers may target despite tortuous nature of road. Factors that decrease the severity include: • Operating speeds below 60km/h. • Overall reduction in speed at expected at former passing lane locations due to replacement of passing lanes with Slow Vehicle Bays. • Presence of Wairarapa railway line reduces volume of heavy vehicles than there might otherwise be.	Factors that increase the severity include: • 100km/h speed limit which some drivers may target despite tortuous nature of road. • Downhill operating speeds likely to be higher. Factors that decrease the severity include: • Operating speeds below 60km/h.	Factors that increase the severity include: • 100km/h speed limit which some drivers may target despite tortuous nature of road Factors that decrease the severity include: • Operating speeds below 60km/h • Presence of Wairarapa railway line reduces volume of heavy vehicles than there might otherwise be • Overall reduction in speed at expected at former passing lane locations due to replacement of passing lanes with Slow Vehicle Bays.	Factors that increase the severity include: • Factors that decrease the severity include: •	Factors that increase the severity include: • 100km/h speed limit which some drivers may target despite tortuous nature of road • High downhill speeds of cyclists Factors that decrease the severity include: • Presence of Wairarapa railway line reduces volume of heavy vehicles than there might otherwise be	Factors that increase the severity include: • High speed limit relative to the recommended safe and appropriate speed Factors that decrease the severity include: • Presence of Wairarapa railway line reduces volume of heavy vehicles than there might otherwise be
Severity Score:	3/4	~~3~~ 2.5/4	4/4	1/4	0/4	4/4	4/4
Product (multiply scores above for crash type)	36/64	~~27~~ 18.75/64	12/64	~~9~~ 7.5/64	0/64	16/64	48/64
						TOTAL	~~164~~ 138.25/448

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