Stantec

SH1 WAIKATO EXPRESSWAY – OHINEWAI
Post-construction Road Safety Audit

26 May 2022

Prepared for:
Waka Kotahi NZ Transport Agency

Prepared by:
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Acronyms / Abbreviations

SiD	safety in design
SAT	safety audit team
RSA	road safety audit
WDC	Waikato District Council
SISD	safe intersection sight distance
SSD	stopping sight distance
km/h or KPH	kilometres per hour
m	metres
RAB	roundabout
SH1	State Highway One
RP	Route Position
RS	Route Station
Rd	Road
St	Street
NZTA	NZ Transport Agency
WK	Waka Kotahi
DS	design speed
WRB	wire rope barrier
RRPM	reflectorised raised pavement markers
WRC	Waikato Regional Council
MMA	methyl methacrylate

Glossary

Safe Intersection Sight Distance	Safe intersection sight distance is the minimum sight distance which should be provided on the major road at any intersection. This distance: • is measured along the carriageway from the approaching vehicle to the conflict point; the line of sight having to be clear to a point 7.0 m (5.0 m minimum) back along the side road from the conflict point • provides sufficient distance for a driver of a vehicle on the major road to observe a vehicle on a minor road approach moving into a collision situation (e.g. in the worst case, stalling across the traffic lanes), and to decelerate to a stop before reaching the collision point • is viewed between two points to provide inter-visibility between drivers and vehicles on the major road and minor road approaches It is measured from a driver eye height of 1.1 m above the road to points 1.25 m above the road, which represents drivers seeing the upper part of cars. • provides sufficient distance for a vehicle to cross the non-terminating movement on two-lane two-way roads, or undertake two-stage crossings of dual carriageways, including those with design speeds of 80 km/h or more • should also be provided for drivers of vehicles stored in the centre of the road when undertaking a crossing or right-turning movement • enables approaching drivers to see an articulated vehicle, which has properly commenced a manoeuvre from a leg without priority, but its length creates an obstruction.
Stopping Sight Distance	Stopping sight distance is the distance to enable a normally alert driver, travelling at the design speed on wet pavement, to perceive, react and brake to a stop before reaching a hazard on the road ahead.
Design Speed	The design speed is a speed fixed for the design and correlation to the geometric features of a carriageway that influence vehicle operation. It is selected during the design process and is related to either the intended operating speed or the posted speed limit of a road or section of road.

1 Introduction

1.1 Safety Audit Definition and Purpose

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

A road safety audit is therefore a formal examination of a road 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 road safety concerns.

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

The primary objective of a road safety audit is to deliver a project that achieves an outcome consistent with Road to Zero and the Safe System approach, which is a safe road system free of death and serious injury. The road safety 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 so 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 road safety audit is summarised as:

'to deliver completed projects that contribute towards a safe road system that is free of death and serious injury by identifying and ranking potential safety concerns for all road users and others affected by a road project.'

A road safety audit should desirably be undertaken at project milestones such as:

- concept stage (part of business case);
- scheme or preliminary design stage (part of pre-implementation);
- detail design stage (pre-implementation or implementation); or
- pre-opening or post-construction stage (implementation or post-implementation).

A road safety audit is not intended to be a technical or financial audit and does not substitute for a design check of standards or guidelines. Any recommended treatment of an identified safety concern is intended to be indicative only, and to focus the designer 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 NZTA Road Safety Audit Procedures for Projects Guidelines - Interim release May 2013 the audit report should be submitted to the client who will instruct the designer to respond. The designer 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 will make the final decision and brief the designer to make the necessary changes and/or additions. As a result of this instruction the designer 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 road safety audit process. A decision tracking table is embedded into the report format at the end of each set of recommendations. It is to be completed by the designer, safety engineer, and client for each issue, and should record the designer's response, client's decision (and asset manager's comments in the case where the client and asset manager are not one and the same) and action taken. Decision tracking of safety concerns ranked as a comment is optional.

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

1.2 The Project

The project consists of 8.2 km long roadside safety barrier installation in combination with various other minor safety works including:

- headlight glare fencing,
- formalised maintenance bays,
- ATP application,
- sealed shoulder width improvements.

The project also ensured that the works were consistent with a pending future posted speed limit increase from 100 km/h to 110 km/h.

The works also included various forms of lighting upgrades however this was ignored by the SAT as no detail was provided for the assessment.

The scope of works commenced from immediately south of Rangiriri Interchange and finished immediately north of the south facing half diamond interchange servicing Huntly to the south.

1.3 The Road Safety Audit Team

This road safety audit has been carried out in accordance with the NZTA Road Safety Audit Procedure for Projects Guidelines - Interim release May 2013, by:

- Nick Overdevest, Senior Principal Transportation Engineer, Stantec (Hamilton), team leader. and
- Keith Weale, Technical Director – Roads and Highways, Stantec (Auckland), team member.

1.4 Previous Road Safety Audits

The safety audit team is aware of a previous detailed design road safety audit undertaken over a study area much greater than what is currently being audited.

That Detailed Design Safety Audit of the SH1: Waikato Expressway Safety Improvements project consisted of four sections of the Waikato Expressway being Ohinewai Section, Ngaruawahia Section, Te Rapa Section and Cambridge Section, with drawings being produced by Beca on behalf of Safe Roads Alliance.

In addition, that Safety Audit Team and other safety audit teams were requested to audit a Safer Speeds Classification for SH1: Waikato Expressway for the following sections:

- Hampden Downs Section,
- Rangiriri and Ohinewai Section,
- Ngaruawahia Section,
- Te Rapa Section,
- Tamahere Section, and
- Cambridge Section.

The Safer Speeds Classification was essentially the pre-implementation of increasing the posted speed of the then completed Waikato Expressway elements from 100 km/h to 110 km/h.

The outcomes of the detailed design audit was adopted in part and superseded by a further memo formulated and issued by Waka Kotahi - WEX: Ohinewai 110 km/h RSA Review (November 2020) – prior to the implementation of this project.

1.5 Scope of this Road Safety Audit

This is a road safety audit of the constructed facility at what we deem to be 95% completion.

The following construction elements were incomplete at the time of the road safety audit and have therefore not been commented on in this report.

- ATP application
- Headlight glare fencing

Further, the safety audit team (SAT) is aware that various lighting improvements were undertaken along the route consisting of LED luminaire upgrades and/or new light pole locations adjusted to ensure that dynamic deflection of the safety barrier system was recognised.

A road safety audit is not to be used as a substitute for design checking or peer review, nor is it a check on compliance with standards, drawings or specifications. In this respect, it is further highlighted that an audit is not intended to provide a check on the compliance of every element but provides an overview of the project and operation with respect to the safety of road users.

While Health and Safety in Design (SiD) aspects are mentioned in the context of this road safety audit, this road safety audit is not a substitute for a separate formal Health and Safety in Design and construction review and workshopping processes.

1.6 Briefing, Audit, and Exit Meetings

The SAT met on Tuesday 17th May 2022 with design representatives from BBO to conduct an entry meeting via a Teams meeting screen sharing of the drawings as required.

The SAT undertook both daytime and night-time site inspections on 17th May 2022.

1.7 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 as a whole, 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 concern assessment rating matrix in Table 1. The qualitative assessment requires professional judgement and a wide range of experience in projects of all sizes and locations.

In ranking specific concerns, the auditors have considered the objectives of the Safe System approach, i.e. to minimise fatal or serious injury crashes.

In undertaking this assessment, the safety audit team has utilised the following descriptor tables to enable a fair and reasonable rating of the risks.

Table 1: Crash Frequency Description

Crash Frequency	Indicative Description
Frequent	Multiple crashes (more than one per year)
Common	1 every 1 to 5 years
Occasional	1 every 5 to 10 years
Infrequent	Less than 1 every 10 years

Crash severity is determined on the likelihood of a crash resulting in death or serious injury. The reader is advised that the severity of an injury is determined in part by the ability of a person to tolerate the crash forces. An able-bodied adult will have a greater ability to recover from higher trauma injuries, whereas an elderly person may have poor ability to recover from high trauma injuries. The auditors consider the likely user composition, and hence the likely severity of injury to that user.

Table 2: Concern Assessment Rating Matrix

Severity (likelihood of death or serious injury)	**Frequency** (probability of a crash)			
	Frequent	**Common**	**Occasional**	**Infrequent**
Very likely	Serious	Serious	Significant	Moderate
Likely	Serious	Significant	Moderate	Moderate
Unlikely	Significant	Moderate	Minor	Minor
Very unlikely	Moderate	Minor	Minor	Minor

While all safety concerns should be considered for action, the client or nominated project manager will make the decision as to what course of action will be adopted based on the guidance given in this ranking process with consideration to factors other than safety alone. As a guide a suggested action for each concern category is given in Table 3.

Table 3: Concern Categories

Concern	Suggested Action
Serious	Major safety concern that must be addressed and requires changes to avoid serious safety consequences.
Significant	Significant safety concern that should be addressed and requires changes to avoid serious safety consequences.
Moderate	Moderate safety concern that should be addressed to improve safety.
Minor	Minor safety concern that should be addressed where practical to improve safety.

In addition to the ranked safety issues, it may be appropriate for the safety audit team to provide additional comments with respect to items that may have a safety implication but lie outside the scope of the safety audit. A comment may include items where the safety implications are not yet clear due to insufficient detail for the stage of project, items outside the scope of the audit such as existing issues not impacted by the project or an opportunity for improved safety but not necessarily linked to the project itself. While typically comments do not require a specific recommendation, the auditors may give suggestions in some instances.

Decision tracking of safety concerns ranked as a comment is optional.

1.8 Documents Provided

The SAT was provided with the following documents for this audit.

Title	Project Number	Date	Revision	Number of Sheets
Cover Sheet	147130-00-1000	4/2021	1	1
Drawing Index and Site Locality Plan	147130-00-1001	15/6/2021	2	1
General Arrangement and Barriers Sheet Layout Plan	147130-00-1200	7/4/2021	1	1
General Arrangement and Barriers Plans	147130-00-1201 to 1215	7/4/2021	Varies	15
Edge Barrier Details – Typical Edge Details	147130-00-2901	7/4/2021	1	1
Edge Barrier Details – Typical Foundation Details	147130-00-2903	7/4/2021	1	1
Headlight Glare Screen – Typical Detail	147130-00-2905	14/2/2021	1	1
Edge Barrier Details – Barrier Transition Types A to I	147130-00-2911 to 2912, 2914 to 2915, 2918 to 2919	7/4/2021	1	6
Edge Barrier Details – Maintenance Access Bay Type 3 to Type 6	147130-00-2922 to 2926	15/6/2021	2	2
Edge Barrier Details – Typical Sections through Maintenance Bays	147130-00-2927	15/6/2021	2	1

Title	Project Number	Date	Revision	Number of Sheets
Edge Barrier Details – Provisional Pavement Details and Dish Channel Detail	147130-00-2928	7/4/2021	1	1
Armitage Road Auxiliary Lane – Extension Details - Plan	147130-00-2931	7/4/2021	1	1
Armitage Road Auxiliary Lane – Extension Details – Typical Sections	147130-00-2936	7/4/2021	1	1
Maintenance Bay Access Details – ERP 0504-D/0.95 - Plan	147130-00-2941	3/2/2022	2	1
Spillway 3 Barrier Replacement – ERP 0504-D/1.25 - Plan	147130-00-2942	22/2/2022	1	1
Maintenance Bay Access Details – ERP 0504-D/0.95 - Sections	147130-00-2946	4/2/2022	2	1
Maintenance Bay Access Details – ERP 0510-R1/0.20 - Plan	147130-00-2961	15/6/2021	1	1
Maintenance Bay Access Details – ERP 0510-R1/0.20 - Sections	147130-00-2966	8/6/2021	1	1
SH 1 WEX Detailed Design RSA	80508736/0103	7/9/2016	B	
WEX: Ohinewai 110 km/h RSA Review		30/11/2020		

1.9 Disclaimer

The findings and recommendations in this report are based on an examination of available relevant plans, the specified road and its environs, and the opinions of the road safety 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. Safety audits do not constitute a design review nor are they 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 safety audit team or their organisations.

2 Unresolved Issues from Previous Road Safety Audit

The following is a list of safety deficiencies that had been raised as a concern under the previous detailed design road safety audit but appear not to have been implemented on site as recommended under the client agreed actions.

2.1 Barriers

2.1.1 OHINEWAI SECTION - DEFICIENT ARMITAGE ROAD DIVERGE MODERATE

Refer to Section 3.1.4 of the previous road safety audit.

The current Armitage Road exit arrangement fails to protect an errant vehicle colliding with the heavily vegetated roadside berm (immediately west of the proposed roadside leading end terminal) or beyond through the exit break.

The SAT notes that the Client Decision and Designers action taken noted that an extension of the barrier down Armitage Road in combination with a crash cushion were to be installed. These assets had not been installed at the time of the audit undertaken.

Figure 1: View looking north towards Armitage Road diverge

It is also noted that a driver steering right of the PW-5 sign in Figure 1 could be directed into the terminal of the wire rope barrier, which could be difficult to see in poor weather conditions e.g. fog at night.

Risk Ranking

The road safety audit team has assigned the following risk ranking to this safety concern.

Frequency rating	Crashes resulting from this safety concern could be infrequent.
Severity rating	Death or serious injury resulting from this safety concern could be likely.
Risk ranking	The safety concern is therefore deemed to be moderate.

Recommendation(s)

1 Consider extending barrier system either side of the exit lane to beyond the 'length of need' measured from the adjacent expressway. Consider a crash cushion at the gore point to protect vehicles from the heavily vegetated roadside berm.

2 Ensure that warning signage in the gore conveys the correct message to approaching drivers.

Decision Tracking

Designer response	1. The Designer agrees that although this is a lower risk area and a reasonable distance from the carriageway it would improve safety if barrier was to be installed down Armitage Road. A Crash cushion was found to be difficult and costly to install at this location due to the gore geometry and need to transition to wire rope barrier. It would also be prone to costly nuisance strikes due to the gore geometry. The hazards are lower risk frangible - small shrubs or flaxes and very similar to other expressway exits with wire rope barrier and no crash cushions. Therefore, the crash cushion wasn't installed. 2. The Designer recommends replacing the PW-5 with an MI-4 ' EXIT' sign (TCD Part 10 - MOTSAM Part 3.4, Figure 3.25)  MI - 4
Client safety engineer comment	
Client decision	
Action taken	

3 Safety Concerns from this Road Safety Audit

3.1.1 ACCESS TO TE ONETEA STREAM AND BOX CULVERT MODERATE

Prior to the roadside barrier works, WRC and their agents had direct access to the stopbank, and to the Te Onetea stream including box culvert and housing, from the adjacent state highway.

Post works, the access to WRC's assets has been restricted to an existing legal access from the northern end of Paitai Road. Maintenance personnel would be required to undertake a return trip of 4.2 km to return to the expressway entry point should they wish to access the Te Onetea Stream box culvert.

There is a risk that the designated access route will be avoided to access the box culvert (or stopbank either side) and that maintenance personnel (untrained in the use of expressway maintenance bays) may utilise an existing maintenance bay access north of Te Onetea Stream box culvert.

Comparatively, this route would effectively shorten the return trip from 4.2 km to 200 m.

Given that the maintenance bay is located on the inside of a horizontal curve, access and sight distance is restricted. This may result in untrained drivers forced to look over their shoulder (or rely on their rear-view mirror) over an area where sight distance is already constrained by the retained stopbank over the Te Onetea Stream box culvert.

Further, unauthorised access movements into the maintenance bay may result in some drivers slowing down within the left lane prior to swinging wide into the maintenance bay.

In isolation (and/or in combination), this may increase the risk of a rear-end crash or entering the carriageway without giving sufficient due diligence to oncoming movements northbound on SH1.

Figure 2: View from the maintenance bay break looking south.

Risk Ranking

The road safety audit team has assigned the following risk ranking to this safety concern.

Frequency rating	Crashes resulting from this safety concern could be infrequent.
Severity rating	Death or serious injury resulting from this safety concern could be likely.
Risk ranking	The safety concern is therefore deemed to be moderate.

Recommendation(s)

1 Consider installing a lockable gate/swing arm at the rear of the maintenance bay to dissuade direct access to the roadside berm behind the barrier. Ensure that any feature installed recognises the dynamic deflection qualities of the adjacent roadside barrier.

2 Alternatively (and or in combination with the prior recommendation), consider consulting with WRC to fence off the Te Onetea Stream accessway from the maintenance bay break.

Decision Tracking

Designer response	The Designer agrees there is a risk that the maintenance access may be used instead of the access via. Paitai Road. 1. We don't recommend placing the gate behind the flexible barrier even if it is out of the tested deflection zone. It would potentially result in other maintenance vehicles parking in front of the gate rather than in a safe location well away from the barrier. 2. This issue has been discussed in detail with both parties through design development and construction phases. It will be passed on again to WRC (Integrated Catchment Management and Operations Teams) and Waka Kotahi System Management Teams to ensure appropriate processes can be put in place to manage access.
Client safety engineer comment	
Client decision	
Action taken	

3.1.2 CYCLIST CROSSING POINT DEFICIENCIES MODERATE

As a result of shoulder widening works, the formalised cycle crossing locations across on/offramps have not been in reinstated to an acceptable standard. In many locations, the cycle crossing pavement markings and signs have not been re-instated.

Without specific guidance, cyclists could cross at locations where it is unsafe to do so, or cross the ramp lanes at paths acutely skewed to the ramp lane resulting in longer than necessary exposure to vehicles within the lane.

Also refer to Section 4.1.1.

Figure 3: View looking south across Armitage Road On-ramp.

Note that the pavement marking in Figure 3 is almost non-existent within the roadside sealed shoulder and gore area.

Risk Ranking

The road safety audit team has assigned the following risk ranking to this safety concern.

Frequency rating	Crashes resulting from this safety concern could be infrequent.
Severity rating	Death or serious injury resulting from this safety concern could be likely.
Risk ranking	The safety concern is therefore deemed to be moderate.

Recommendation(s)

1 Reinstate cycle crossing pavement marking and signage.

2 Reinstate hold rails at locations where it is safe to do so.

Decision Tracking

Designer response	1. The Designer agrees cycle markings required remarking. This will be added to the defects list for rectification. 2. The Designer does not recommend cycle hold rails. They present a hazard and would not be well used due to the low number of cyclists and likelihood any cyclists who are on the expressway will be competent enough not to require them.
Client safety engineer comment	
Client decision	
Action taken	

3.1.3 VARIOUS ROAD SAFETY BARRIER DEFICIENCIES MINOR

The following safety barrier deficiencies were noted.

1. The new w-section curved terminal (radius measures 10 m on the construction drawings) adjacent to the existing accessway (RP 504/1.82 LHS) has the w-section bolted to each post. The apex of the curved terminal should sit on a shelf system where the w-section is not bolted to the posts.

   Without the shelf system in place the risk increases for an errant vehicle to vault over or penetrate the guardrail; or, in the event that the vehicle is contained by the guardrail, the resulting decelerating forces may exceed the recommended limits for occupant safety.

Figure 4: View looking south towards the curved terminal.

Note that the w-section barrier in Figure 4 is bolted to each post.

2. The new roadside wire rope barrier in front of Waikato Woolscourers (northbound lane) appears to transition vertically from the edge of sealed shoulder to the kerb and channel (and vice versa downstream) over the sealed shoulder component prior to the kerb and channel. Consequently, the bottom wire is significantly higher than the proprietary supplier's requirement to retain an errant vehicle i.e. the bottom wire is approximately 680mm above the existing carriageway vs a proprietary requirement of 570 mm. There is a risk that vehicles will penetrate the barrier under the horizontal strands of wire resulting in an increased risk of occupant injury.

   The SAT notes that it is preferable that the vertical transition occurs over the kerb and channel component as an errant vehicle is likely to remain in compression after initially striking the kerb in front of the wire rope barrier.

Figure 5: View depicting 680mm clearance under the bottom strand of wire

3. Many of the wire rope barrier terminals are not sufficiently delineated with an approved delineation system such that the terminal can be seen during low lighting conditions and/or at night.

   This is further exacerbated by the form of terminal adopted i.e. Mashflex TL-3 end terminal. This proprietary product consists of a very low height post (350 mm) at post one, followed by a large gap to post two - approximately 10 m beyond. The lack of delineation and the subsequent gap between posts one and two may confuse some drivers as they pull over clear of the lane and/or wish to enter the adjacent maintenance bays, particularly at night.

   There is a risk that vehicles may inadvertently mount the terminal resulting in undercarriage damage or inadvertently pushing them into the adjacent through lane. Figure 6 illustrates how the gap can appear to be between the full height posts and how invisible the short post (yellow arrow) would be when it becomes coated in dirt.

Figure 6: Maintenance bay gap in barrier

Risk Ranking

The road safety audit team has assigned the following risk ranking to this safety concern.

Frequency rating	Crashes resulting from this safety concern could be occasional.
Severity rating	Death or serious injury resulting from this safety concern could be unlikely.
Risk ranking	The safety concern is therefore deemed to be minor.

Recommendation(s)

1 Consider installing a shelf-based system along the apex of the curved rail terminal.

2 Consider transitioning the vertical transition over the kerb and channel component given the balance of risk involved.

3 Consider reviewing the delineation of all WRB terminals and improve delineation of the anchor system, post one and two to improve conspicuousness.

Decision Tracking

Designer response	1. The Designer agrees the apex post should be on a shelf - this is on the defects list for rectification. 2. The Designer has spoken to the system manufacturer (Ingal). They have no concerns regarding barrier performance with the bottom wire rope height being 680mm and out of tolerance (570mm -10/+30mm) for this short section. 3. The Designer agrees - end terminal delineation has been added to the defects list for inclusion. W20-4 Hazard Markers will be used.
Client safety engineer comment	
Client decision	
Action taken	

3.1.4 LOOSE MATERIAL ALONG THE SEALED SHOULDER MINOR

There are a number of instances where loose chip and/or rock was sitting on the sealed shoulder. Left in its current state, the loose material may eventually migrate onto the lane and present a loss of traction hazard for vehicles or increase the risk that these items become an airborne missile.

The loose material is also a hazard for cyclists.

Figure 7: View looking north, north of Armitage Road on-ramp.

Note excessive sealing chip on sealed shoulder.

Figure 8: View looking north along the southbound lane, north of Armitage Road on-ramp.

Note the large coarse aggregate on the sealed shoulder.

Risk Ranking

The road safety audit team has assigned the following risk ranking to this safety concern.

Frequency rating	Crashes resulting from this safety concern could be occasional.
Severity rating	Death or serious injury resulting from this safety concern could be unlikely.
Risk ranking	The safety concern is therefore deemed to be minor.

Recommendation(s)

1 Sweep the shoulders to remove all loose chips and coarse aggregate.

Decision Tracking

Designer response	The Designer agrees - this is on the defects list to rectify.
Client safety engineer comment	
Client decision	
Action taken	

3.1.5 VARIOUS SIGNAGE AND DELINEATION CONCERNS MODERATE

The SAT recognises that the construction phase is still ongoing and that there are some areas where some finishing off is required. In particular ATP has yet to be implemented. Consequently, there is some fine tuning still to be undertaken.

The following is a list of signage and delineation concerns that could be further improved: -

1. The auxiliary lane prior to Armitage Road appears to be confusing and inconsistent. For example, a portion of the left-hand edge line is missing, and the old cycle lane buffer line has been reinstated in part (noting that the secondary buffer line beyond has not been reinstated for the remainder of the project).

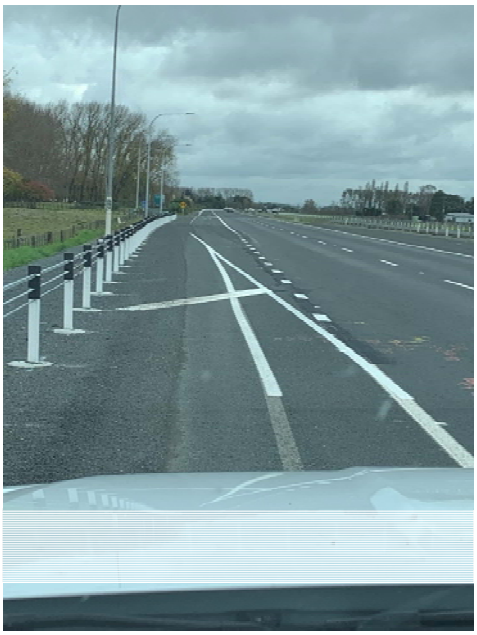

Figure 9: Note pavement marking deficiencies

2. The edge line delineation is inconsistent at night, particularly the application of RRPMs to the left of the remarked left hand edge line. The project appears to consist of either no RRPMs and/or sporadic use of red and white RRPMs. The project should be well delineated and appear consistent with the remaining Waikato Expressway sections where red RRPMs have been installed to the left of the roadside edge line/ATP, and orange RRPMs to the right of the median edge line.

3. Some signage and other related assets have not been re-erected as a result of the road safety barrier installation works. A few examples are the "Expressway" signs, "Cross here with care" signs and hold rails for cyclists etc.

Figure 10: "Expressway" sign lying on the roadside berm

In Figure 10 the expressway sign is lying behind the barrier near the Armitage Road on-ramp.

Risk Ranking

The road safety audit team has assigned the following risk ranking to this safety concern.

Frequency rating	Crashes resulting from this safety concern could be infrequent.
Severity rating	Death or serious injury resulting from this safety concern could be likely.
Risk ranking	The safety concern is therefore deemed to be moderate.

Recommendation(s)

1 Improve Armitage Road auxiliary lane marking by removing the secondary edge line on the roadside, and ensure that the roadside edge line is continuous.

2 Install red RRPMs to the left of the roadside edge line (ensuring that there is sufficient space to retrofit the ATP between the RRPMs and existing edge line). Install orange RRPMS to the right of the median edge line (and subsequent ATP application).

3 Erect missing signs and hold rails, as necessary.

Decision Tracking

Designer response	1. The Designer agrees - this is on the defects list to be rectified. 2. The Designer agrees consistent and enhanced delineation would improve safety. This was not part of the project scope but could be undertaken by the NOC or by the project if the scope is extended. 3. The Designer agrees the signs are to be reinstated - This has been added to the defects list. Refer to Designers' response to 3.1.2 for cycle hold rails - we don't anticipate they will be well used and recommend leaving them out.
Client safety engineer comment	
Client decision	
Action taken	

4 Safety Concerns beyond the Scope of this Project

The following safety concerns that extend beyond the immediate scope of the project are included in this separate section, as it may not be possible for the designer to respond to these concerns. Nonetheless, the client should take note of these concerns when considering the wider impact of the proposed scheme or further safety enhancements that could be included with this scheme.

4.1.1 CYCLE CROSSING POINTS COMMENT

The appearance and state of the cycle crossings vary across the broader Waikato Expressway. Ideally these crossing points should appear consistent to cyclists and drivers alike.

The existing crossing points within the study area are either non-existent, in various states of disrepair and/or not sufficiently intuitive. The following is a list of crossing point deficiencies that existed prior to, and are unrelated to the current works. These deficiencies are not an exhaustive list but merely examples of non-conformance and/or the state of disrepair.

- Hold rails missing i.e. Armitage Road off-ramp, or not securely attached within ground mounted sockets i.e. Tahuna Road northbound on-ramp.
- Missing "Cross here with care" sign i.e. Tahuna Road southbound off-ramp.
- Incomplete and/or missing pavement marking to guide cyclists to the crossing location i.e. Armitage Road Northbound on-ramp.
- Lack of delineation, particularly under diminished light conditions i.e. markings have not been remarked as part of scheduled pavement marking maintenance.
- Lack of maintenance around the crossing points. There is an accumulation of sealing chip and rubbish at these locations putting cyclists at risk.

The cycle crossing points within the Huntly Section of the Waikato Expressway (adjoins this project to the south) consists of green MMA application to the approach and departure components to the crossing points. Further, additional pavement marking in the form of guidance arrows and give way symbols within the cycle lane provide additional guidance for cyclists. The SAT considers the Huntly Section cycle crossing points are clear, concise, intuitive and are of a high standard and delineation.

Recommendation(s)

1 The SAT recommends that the cycle crossing points are reviewed with the maintenance contractor, and made more consistent with the Huntly Section of the Waikato Expressway.

Since this safety concern is ranked as a comment, decision tracking in the table below is optional.

Optional Decision Tracking

Designer response	The above issues have been passed onto the System Management Team to incorporate in annual programmes.
Client safety engineer comment	
Client decision	
Action taken	

5 Comments

The following comments are either:

- of a general nature; or
- cannot be related to any specific safety concern; or
- relate to previous safety concerns that may have been misinterpreted; or
- relate to subsequent design developments that could become safety concerns in a future safety audit; or
- relate to safety concerns that the designers are already aware of; or
- relate to design elements where the safety implications are not yet clear due to insufficient detail for the stage of the project.

These comments are included for the consideration of the designers and the client. Decision tracking tables are included to record responses, as attention paid to the comments may contribute to improving overall road safety.

5.1 Road markings

5.1.1 LACK OF ATP APPLICATION GUIDANCE COMMENT

The SAT acknowledges that the ATP element has yet to be marked. The SAT also notes that there is little guidance within the construction drawings regarding where ATP is applied relative to the painted edge line.

From experience, the SAT has noted that there might be some confusion within the industry where the ATP is applied relative to the edge line as numerous instances of ATP application on top of the edge line or on top of the RRPMs has been observed.

The SAT wishes to highlight that the ATP is always marked outside and adjacent to the edge line. This ensures that the auditory component of the ATP is activated once a vehicle strays from the lane as opposed to within the lane. This application strategy also reduces “nuisance noise” associated with ATP.

Furthermore, the RRPMs should be outside the ATP as the ATP ridges obscure the RRPMs partially and reduce their effectiveness.

Recommendation(s)

1 Consider updating the construction drawings to remove all uncertainty.

Since this safety concern is ranked as a comment, decision tracking in the table below is optional.

Optional Decision Tracking

Designer response	The project decision was made to mark ATP on the edge line for consistency with the Huntly section.
Client safety engineer comment	
Client decision	
Action taken	

6 Audit Statement

We declare that we remain independent of the design team and have not been influenced in any way by any party during this road safety audit.

We certify that we have used the available plans, and have examined the specified roads and their environment, to identify features of the project we have been asked to look at that could be changed, removed, or modified in order to improve safety.

We have noted the safety concerns that have been evident in this audit and have made recommendations that may be used to assist in improving safety.

Signed s 9(2)(a) Date 24 May 2022

s 9(2)(a)
Senior Principal Transportation Engineer, Stantec

Signed s 9(2)(a) Date 26 May 2022

s 9(2)(a)
Technical Director – Roads and Highways, Stantec

7 Response and Decision Statements

System designers and the people who use the roads must all share responsibility for creating a road system where crash forces do not result in death or serious injury.

7.1 Designer's Responses

I have studied and considered the auditors' safety concerns and recommendations for safety improvements set out in this road safety audit report and I have responded accordingly to each safety concern with the most appropriate and practical solutions and actions, which are to be considered further by the safety engineer (if applicable) and project manager.

Signed _____ Date _____

Designer's name, qualification, position, company

7.2 Safety Engineer's Comment (if applicable)

I have studied and considered the auditors' safety concerns and recommendations for safety improvements set out in this road safety audit report together with the designer's responses. Where appropriate, I have added comments to be taken into consideration by the project manager when deciding on the action to be taken.

Signed _____ Date _____

Safety engineer's name, qualification, position, company

7.3 Project Manager's Decisions

I have studied and considered the auditors' safety concerns and recommendations for safety improvements set out in this road safety audit report, together with the designer's responses and the comments of the safety engineer (if applicable) and having been guided by the auditor's ranking of concerns have decided the most appropriate and practical action to be taken to address each of the safety concerns.

Signed _____ Date _____

Project manager's name, qualification, position, company

7.4 Designer's Statement

I certify that the project manager's decisions and directions for action to be taken to improve safety for each of the safety concerns have been carried out.

Signed _____ Date _____

Designer's name, qualification, position, company

7.5 Road Safety Audit Close Out

The project manager is to distribute the audit report incorporating the decisions to the designer, safety audit team leader, safety engineer, and project file.

Date _____