DETAILED DESIGN ROAD SAFETY AUDIT REPORT

SH 1: Waikato Expressway Safety Improvements and Safer Speeds Classification

Prepared for Safe Road Alliance

September 2016

MWH now part of Stantec

QUALITY STATEMENT

PROJECT MANAGER	AUDIT TEAM LEADER
s 9(2)(a)	s 9(2)(a)

PREPARED BY	s 9(2)(a)	06/09/2016
REVIEWED BY	s 9(2)(a) (Opus)	06/09/2016
APPROVED FOR ISSUE BY	s 9(2)(a)	07/09/2016

HAMILTON
468 Tristram St, Whitiora, Hamilton 3200
PO Box 13-052, Armagh, Christchurch 8141
TEL +64 7 839 0241, FAX +64 7 839 4234

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Safe Road Alliance

Detailed Design Road Safety Audit Report

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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 Safer Journeys and the Safe System approach, which is a safe road system increasingly 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 increasingly 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 NZ Transport Agency 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.

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 Road Safety Audit Team

This road safety audit has been carried out in accordance with the NZ Transport Agency's Road Safety Audit Procedure for Projects Guidelines – Interim release May 2013, by:

- s 9(2)(a) – MWH New Zealand Ltd - Hamilton Office (Team Leader)
- s 9(2)(a) - Opus International Consultants Ltd - Hamilton Office (Team Member)

The audit consisted of a day and night inspection. The audit was carried out during the afternoon of Tuesday 23rd August 2016 in overcast conditions and was carried out in accordance with the Stage 3 audit checklists as set out in the NZ Transport Agency's Safety Audit Procedures for Projects document (May 2013). Prior to carrying out the audit, the team met with the designers (Caleb McCarthy and Jamie Minchington of BBO) to confirm scope, determine the issues and understand some of the decision making processes that were considered during the detailed design phase.

The main audit involved examining the detailed design drawings, driving through the site a number of times in both directions and then inspecting particular parts of the roadway. A night time inspection was also undertaken to understand delineation and reflectivity of the new barrier system, markings and signage, and to ensure that the future proofing element (particularly adjacent to the Hamilton Section tie-in) does not confuse drivers at night.

1.3 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 1-1. The qualitative assessment requires professional judgement and a wide range of experience in projects of all sizes and locations.

Table 1-1: 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 1-2.

Table 1-2: 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 is 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, in some instances suggestions may be given by the auditors.

1.4 Documents Provided

Detail design drawings were provided to the audit team for this RSA. The assessment has been broken up into two distinct project works. The Waikato Expressway Safety Improvements drawings are listed in Table 1-3 below. And, the Waikato Expressway Safer Speeds Classification drawings are also listed in Table 1-4 below.

Table 1-3: List of Waikato Expressway Safety Improvements Design Detail Drawings Supplied for RSA

Drawing No.	Revision No.	Drawing Title
		SH 1 Waikato Expressway – Ohinewai Section
SRA-38D-CE-1001	A	Sheet Index and Locality Plan
SRA-38D-CE-1200 to 1214	A	General Arrangement and Barrier Plans
SRA-38D-CE-2901 to 2902	A	Barrier Edge Details
SRA-38D-CE-2911 to 2916	A	Barrier Transition Details
SRA-38D-CE-2921 to 2927	A	Maintenance Access Bays
		SH 1 Waikato Expressway – Ngaruawahia Section
SRA-38E-CE-1001	A	Sheet Index and Locality Plan
SRA-38E-CE-1200 to 1220	A	General Arrangement and Barrier Plans
SRA-38E-CE-2901 to 2902	A	Barrier Edge Details

Drawing No.	Revision No.	Drawing Title
SRA-38E-CE-2911 to 2916	A	Barrier Transition Details
SRA-38E-CE-2921 to 2927	A	Maintenance Access Bays
		SH 1 Waikato Expressway – Te Rapa Section
SRA-38F-CE-1001	A	Sheet Index and Locality Plan
SRA-38F-CE-1200 to 1210	A	General Arrangement and Barrier Plans
SRA-38F-CE-2901 to 2902	A	Barrier Edge Details
SRA-38F-CE-2911 to 2916	A	Barrier Transition Details
SRA-38F-CE-2921 to 2927	A	Maintenance Access Bays
		SH 1 Waikato Expressway – Cambridge Section
SRA-38G-CE-1001	A	Sheet Index and Locality Plan
SRA-38G-CE-1200 to 1202	A	General Arrangement and Barrier Plans

Table 1-4: List of Waikato Expressway Safer Speeds Classification Detail Design Drawings Supplied for RSA

Drawing No.	Revision No.	Drawing Title
		General
SRA-38H-CE-2801	A	Signage Details Sheet 1 of 1
		Rangiriri and Ohinewai Sections
Sheets 1 to 8		Signs Drawings
		Ngaruawahia Section
SRA-38E-CE-2801 to 2803	A	Signs and Markings Plan
		Te Rapa Section
SRA-38F-CE-2801 to 2804	A	Signs and Markings Plan
		Cambridge Section
Sheets 1 to 7		Signs Drawings

1.5 Previous Audit

The Safety Audit Team are unaware of any other road safety audits being carried out on this project.

1.6 Audit Scope

This audit is a Detailed Design Safety Audit of the SH1: Waikato Expressway Safety Improvements (four sections of the Waikato Expressway being Ohinewai Section, Ngaruawahia Section, Te Rapa Section and Cambridge Section) drawings produced by Beca on behalf of Safe Roads Alliance.

In addition, the Safety Audit Team was also requested to audit a Safer Speeds Classification for SH1: Waikato Expressway for the following sections:

- Rangiriri and Ohinewai Section,
- Ngaruawahai Section,
- Te Rapa Section, and
- Cambridge Section.

The objective of the Safety Audits are to improve severity of outcomes. Consequently, the Safety Audit Team is tasked with looking for safety issues arising from the proposed works. The intent is **not** to be a process of identifying minor non-compliances with industry guidelines, as there is a quick turnaround between the implementation phase (part of which the safety audit sits within), and the construction phase.

1.7 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 SAT. 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 to 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.

1.8 Client Review

Client review has been undertaken by James Hughes, National Design Engineer, and Graham Taylor, National Network Optimisation Manager, both of whom are based in the NZ Transport Agency National Office.

Some of the Safety Audit recommendations, Designer Responses and Safety Engineer comments have not been implemented as part of the client decision. This is in no way a reflection on the quality of the audit and responses/comments which, in our view, have been carried out appropriately.

2 Project Overview

This project is split into four sections along the Waikato Expressway for the Safety Improvements element of the audit. The four sections are as follows:

- Ohinewai Section – RP 0502/1.65 to 9.72
- Ngaruawahia Section – RP 0527/0.54 to 0534/4.15
- Te Rapa Section - 0534/3.9 to 0540/5.00
- Cambridge Section – 0557/3.42 to 4.60

These sections are currently subject to a 100km/h speed restriction although we are aware that the NZ Transport Agency is considering an increased 110 km/h 'Safer Speeds' across significant lengths of the study area. This forms part of the second assessment for this Safety Audit. In addition to the sections above, the Safer Speeds Classification also includes the Rangiriri Section from RP 0486/15.24 to abut into the Ohinewai Section to the south.

The project comprises upgrading the existing road based on meeting the investment benefits as defined by the Business Case for SH 1 Waikato Expressway. The Business Case project recommended a preferred option which had been selected via a multi criteria analysis including factors such as actual predicted Death Serious Injury (DSI) reduction, technical risk, financial constraints, timeframes and other items.

Due to the risk profiles assessed, the treatments are likely based on a philosophy of 'safety management' by carrying out the following site specific works:

- Increasing sealed shoulder widths in parts (where a severe roadside risk exists).
- Widening the carriageway to accommodate a roadside Safety Barrier along the full length.
- Providing and formalising maintenance access points/breaks along the continuous safety barrier system.
- Upgrading entranceways and closing entrances where required.

The location of those treatments were largely selected by using KiwiRAP and Road Protection Scores (RPS) and on site investigation.

The surrounding land use is generally a mixture of dairy, lifestyle blocks, sheep/beef farms and tourist enterprises.

As a result of the information furnished to the auditors and subsequent site inspection we have noted the following:

- A number of active work sites associated with other committed Waikato Expressway works (i.e. the Rangiriri and Huntly sections) that would directly impact on the proposal submitted.
- A number of private entranceways which are still being retained as part of the Safety Improvement projects. The retention of these private access-ways appear to be inconsistent with the objectives of these works.

3 Safety Concerns and Recommendations

3.1 Waikato Expressway Safety Improvements

3.1.1 Ohinewai Section – Trailing Safety Barrier System from Private Access-ways

Minor

The current proposal for accessways relies on a W-Section arrangement (to RSB-2) curving from the access-way gate, extending to overlap in front of the preferred WRB system at both private access-ways at Station 1.78, 2.25, 2.88 and 6.33.

This system effectively becomes non-gating immediately in front of the WRB terminal. This means that if an errant vehicle strikes the curved component, the barrier is likely to fail and let the vehicle through and/or decelerate rapidly resulting in the potential for occupant harm.

A desirable outcome is to present a leading end terminal and safety barrier system with an approved taper in relation to the through lane such that an errant vehicle will be guided by the barrier system when struck.

Recommendation(s)

Consider replacing the curved W-Section barrier system with the more forgiving WRB system. The WRB taper could commence nearer to the access-way gate and immediately behind the prolongation of the leading impact angle from the preceding trailing end terminal.

Frequency Crashes are likely to be infrequent	Severity Death or serious injury is unlikely	Rating The safety concern is minor
Designer response	The designer notes the comments of the SAT. The space available does not allow for a flare of a WRB to provide continuous protection as a flare is also needed for the diverge/'left in' movement. The proposed Curved Rail Terminal is a standard NZ Transport Agency detail RSB-2 as shown in the Technical Memorandum TM-2008. We consider this to be an appropriate barrier treatment for this location.	
Safety Engineer comment	Accept curved rail treatment as appropriate for these locations	
Client decision	Agreed	
Action taken		

3.1.2 General - Deficient lateral location of Safety Barriers adjacent to Off-ramps

Moderate

The drawings appear to locate new barriers with a 3m offset from the road side lane line through the project, including off-ramps.

At off-ramps it is essential that adequate sight distance is provided so that drivers have sufficient time to see and react to the exit and diverge areas. This is particularly important in rural areas where drivers are generally less alert than in urban situations.

The sight distance for an off-ramp treatment should be equivalent to ten seconds of travel time at the operating speed of the expressway (equivalent to 300m for a Posted Speed Restriction = 100km/h or 330m for a Posted Speed Restriction = 110km/h).

Failure to provide adequate sight distance may result in drivers diverging to the left late and either running through the off-ramp nose (and into the barrier system), interacting with a following vehicle also exiting the through road, or losing control of the vehicle.

We list the following as examples where sight distance measures significantly less than ten seconds:

- Ohinewai Section: Ohinewai Northbound Off-ramp,
- Te Rapa Section: SH 39 Southbound Off-ramp, and
- Te Rapa Section: SH 39 Northbound Off-ramp,

Recommendation(s)

Check sight distance to pavement marking is observed at start of diverge taper and at centre of off-ramp lane adjacent to ramp nose. Ensure sight distance is maintained based on the relevant post speed restriction adopted for the Waikato Expressway.

Frequency **Crashes are likely to be occasional**	**Severity** **Death or serious injury is likely**	**Rating** **The safety concern is moderate**
Designer response	Ohinewai Section northbound Off-ramp sight distance = 305m. It is suggested that the new barrier leading up to this interchange be located 3.5m offset from edge line to provide ≥335m Sight distance. The drawings will be amended to include this adjustment Te Rapa Section SH39 Southbound Off-ramp sight distance = 288m (controlled by existing barrier) In this location the existing wire rope barrier could be relocated a further 1.5m for a total offset of 4.5m from the edge line to achieve the appropriate sight distance. This would require some re-grading of the berm area and possibly some adjustment to the existing drainage swale alignment. The current barrier location achieves a 288m sight distance which is equivalent to 9.5 sec. travel time at 110km/h. We request NZTA instruction to amend the existing barrier, berm and swale in this location to achieve 10 sec. travel time at 110km/h. Te Rapa Section SH39 Northbound off-ramp achieves a sight distance > 335m. No adjustment required	
Safety Engineer comment	Agree with designer's proposed amendments to drawings for new barrier at Ohinewai northbound off-ramp At Te Rapa SH39 southbound on-ramp it is preferred that the existing barrier is relocated to achieve 330m (or 10sec travel time at 110km/h). Obtaining an cost estimate for the necessary works is desirable. We understand that the designer has checked the other off-ramps and no further deficiencies were identified.	
Client decision	Modern design practise is to design at the speed limit and not 10km/h above. This reflects the significant reduction in speed profiles. Hence 305m is the appropriate sight distance for 10 seconds of travel. 10 seconds is desirable for the safe recognition of the approaching exit and the associated decision time. However we are satisfied that a minor reduction to 9.5 seconds is acceptable.	
Action taken		

3.1.3 General - Deficient WRB laps with existing Safety Barrier Systems

Moderate

The SAT has identified a number of deficiencies as it relates to WRB terminations with existing safety barrier systems as follows:

1. Proposed leading WRB and terminal lapping in front of an existing trailing barrier end terminal. This arrangement places a terminal (and potential hazard) to oncoming traffic. A safer alternative is to locate the leading terminal behind the existing trailing safety barrier end terminal. The following areas are highlighted where this arrangement occurs:
    - Cambridge Section: Station 3.8 LHS
2. Proposed trailing WRB and terminal laps behind an existing leading barrier end terminal. This arrangement presents the same safety concerns as highlighted in (1) above. A safer alternative is to locate the proposed trailing terminal in front of the existing leading safety barrier end terminal. The following areas are highlighted where this arrangement occurs:
    - Ohinewai Section: Station 7.88 LHS
    - Ohinewai Section: Station 8.11 RHS
    - Ohinewai Section: Station 8.98 LHS
    - Ngaruawahia Section: Station 1.44 LHS
    - Ngaruawahia Section: Station 6.18 LHS
    - Ngaruawahia Section (Southbound): Station 0.67 LHS
    - Ngaruawahia Section (Southbound): Station 0.74 RHS
    - Ngaruawahia Section (Southbound): Station 2.47 LHS
    - Ngaruawahia Section (Northbound): Station 3.39 RHS
    - Ngaruawahia Section (Southbound): Station 3.74 LHS
    - Te Rapa Section: Station 1.25 RHS
    - Te Rapa Section: Station 2.23 LHS
    - Te Rapa Section: Station 2.42 RHS
    - Te Rapa Section: Station 3.66 LHS
3. Proposed WRB terminal laps in front of existing safety barrier terminals have insufficient lateral clearance and/or lap length to ensure that a safety barrier performs as intended. The following areas illustrate these deficiencies:
    - Ohinewai Section: Station 9.46 RHS (requires 1.2m separation, actual separation = 0.9m)
    - Cambridge Section: Station 3.80 LHS (requires 1.2m separation, actual separation = 0.3m. Overlap length also deficient)
    - Cambridge Section: Station 3.81 RHS (requires 1.2m separation, actual separation = 0.6m. Overlap length also deficient)

Recommendation(s)

The Safety Audit Team requests that the designer considers:

- commencing the proposed leading end WRB terminal behind existing safety barrier system,
- terminating the proposed trailing end WRB terminal in front of existing safety barrier system. If necessary, consider removing the terminal on the existing barrier system and extend to lap behind proposed barrier system,
- extending existing safety barrier system to terminate behind new barrier system with required lateral clearances and overlap lengths observed.

Frequency **Crashes are likely to be common**	**Severity** **Death or serious injury is unlikely**	**Rating** **The safety concern is moderate**
Designer response	1. The designer notes that lapping a WRB in front of a W-section barrier is not the preferred option. The existing flare in the w-section barrier constrains the space for the WRB to commence behind. We will adjust the design on the Cambridge section to remove the existing flared leading/trailing terminals, install new straight	

Frequency Crashes are likely to be common	Severity Death or serious injury is unlikely	Rating The safety concern is moderate
	leading/trailing terminals and terminate the new wire rope barriers behind the w-section barrier terminals as per our detail drawings CE-2911 and CE-2912. This is similar to the arrangement shown on NZTA Technical Memorandum TM-2013 Nov 2014, Drawing RSB-7a. 2. Our detail terminating the new WRB behind the W-section terminal is as recommended on Drawing RSB-7a, NZTA Technical Memorandum TM-2013 Nov 2014. 3. Though to scale, barrier transitions on the GA Plans are diagrammatic and refer to transition details (CE-2911 through CE-2916) which detail the required separations. In these cases, the barriers have 0.9m separation at the end of the w-section and flare to 1.2m as recommended on Drawing RSB-7a, NZTA Technical Memorandum TM-2013 Nov 2014	
Safety Engineer comment	1. Agree that installation of new straight terminal ends as per drawings on NZTA Technical memorandum TM-2013 Nov 2014 is appropriate. 2. Agree that barrier terminals should be as per drawings on NZTA Technical memorandum TM-2013 Nov 2014. 3. The details provide more accurate detail for construction of the barrier transitions including the required clearances and overlap lengths.	
Client decision	Agreed that compliance with NZTA Technical memorandum TM-2013 Nov 2014 is the appropriate approach	
Action taken		

3.1.4 Ohinewai Section - Deficient Armitage Road Diverge

Moderate

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.

Recommendation(s)

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.

Frequency Crashes are likely to be infrequent	Severity Death or serious injury is likely	Rating The safety concern is moderate
Designer response	The designer acknowledges the SAT comment. The designer suggests that the vegetation behind the leading terminal could be removed for a distance of 30m to satisfy the SAT concerns. It is noted that the vegetation in this location comprises entirely of frangible flax bushes which in themselves provide an effective deceleration medium and also act as an existing headlight glare screen for vehicles traveling south on Armitage Rd at night. Though there will not be continuous edge protection at this point. Armitage Road is expected to provide an appropriate flat, clear run-out length should a vehicle gate through the leading terminal or the gap in the barriers, without the risk of striking hazards.	

Frequency	Severity	Rating
Crashes are likely to be infrequent	Death or serious injury is likely	The safety concern is moderate

It is noted that the Flax at this location acts as a glare screen to oncoming traffic and, in the event of being struck by a vehicle, acts in a frangible manner.

Safety Engineer comment	There is the potential for removal of the flax to reduce the effectiveness of the glare screen creating a new safety issue. Prefer that a crash cushion and W-section barrier is installed alongside the vegetation to provide protection, particularly when considering the risk to motorcyclists. It is acknowledged that the edge protection is not continuous which is undesirable, however Armitage Rd provides a traversable runout for errant vehicles that do not strike the barrier.
Client decision	The risk to a vehicle that hits the flax is little greater than the risk of injury from hitting a crash cushion or a barrier gate. That, combined with the available clear area, leads to retaining the flax screen and accepting the small gating risk.
Action taken	

3.1.5 General – Safety Barrier System Conflict with existing Light Poles

Moderate

The Designer has advised that where existing light poles are retained behind the new barrier system, the light poles will not be relocated. There is a risk that should the light pole be located within the dynamic deflection distance of the WRB, the light pole may become dislodged after a WRB vehicle strike and may become airborne.

At the very least, the light pole is unusable and illumination of the roadway is affected. At the other extreme end, an airborne pole may endanger adjacent vulnerable users such as cyclists or pedestrians.

Further, the drawings are silent on undisturbed light poles in front of the new barrier system. If left in place, these will present a hazard for all forms of road users.

Recommendation(s)

Consider the following:

- Relocate all affected light poles to sit behind the new barrier system to achieve a dynamic lateral clearance to the face of the pole. If this cannot be achieved, consider relocating poles beyond the dynamic deflection distance in areas where there is a high personal and collective risk to vulnerable users such as cyclists and pedestrians i.e. along the Te Rapa Section (where off-road paths are in close proximity), and in the vicinity of interchanges.
- Ensure all light poles are located behind the new safety barrier system.

Frequency Crashes are likely to be frequent	Severity Death or serious injury is very unlikely	Rating The safety concern is moderate
Designer response	For clarification, existing light columns that are positioned in front of new barrier locations will be relocated behind the new barrier. The notes on the Drawings have been improved to make this clear. Light poles behind the barriers are to remain (even when within the deflection zone. All these are frangible light columns. Currently on the Network, NZTA has accepted shear base light columns within the deflection zone. The above approach has been agreed in the 'Key Corridor Safety Retrofit Project Scope Confirmation document between the Safe Roads Alliance (Jack Donaghy) and the Agency (Graham Taylor) dated 5th August 2016.	
Safety Engineer comment	Would prefer that the existing light columns were relocated beyond the deflection zone, but recognise this deficiency is accepted elsewhere. Where possible these columns should be relocated by the maintenance team as part of the renewal programme or when damaged. The maintenance team and contractor should be made aware of these locations to ensure that the shear base columns are correctly torqued to operate as designed. The designer should liaise with the maintenance team to ensure these actions are passed on.	
Client decision	Acceptance of existing shear base or energy absorbing lighting poles within the deflection zone is confirmed. Any new poles should be outside the tested deflection zone.	
Action taken		

3.1.6 Te Rapa Section – Deficient WRB Break for Cyclists exiting/entering the Expressway

Moderate

The current proposal relies on providing a narrow WRB break to allow cyclists to exit the expressway at Station 3.32 RHS and 3.39 LHS.

The 5m wide break, in culmination with the WRB terminals either side, effectively provides a 25m long gap in the safety barrier system where a vehicle is allowed to gate through the system. The gap further exposes users on the adjacent shared path and fails to protect the occupants of an errant vehicle.

Recommendation(s)

Consider modifying the arrangement to be more consistent with that adopted on the Cambridge Section (ie North of Pickering Road Underpass) where a parallel barrier is implemented across the break and behind the primary barrier system adjacent to the expressway.

Alternatively, consider providing cycle connectivity via an arrangement similar to Maintenance Access Bay Type 3.

Frequency Crashes are likely to be infrequent	Severity Death or serious injury is very likely	Rating The safety concern is moderate
Designer response	The designer agrees with the SAT comments. The design has been modified to relocate the shoulder exit point further upstream by approx. 60m on each side, run the cycle path parallel to the shoulder 2.0m behind the new WRB then connect back to the existing cycle path. An approx. 70m length of new W-section barrier will be installed behind the new parallel section of cycleway to capture errant vehicles exiting the carriageway through the barrier gap and to protect users of the adjacent shared path. These adjustments will require modifications to the existing water quality swales and the position of the cycle path exits from the carriageway shoulder.	
Safety Engineer comment	Agree that the barrier arrangement should be modified to provide a parallel barrier system. There has been some negative feedback from cyclists about the tight alignment of the arrangement adopted on the Cambridge section make it difficult or use by requiring cyclists to significantly slow down. The proposed arrangement should be reviewed in consultation with cyclists to ensure it is easily used by them.	
Client decision	The requirement for cyclists to slow down over a short distance is a minor inconvenience and needs to be weighed against the cost of a higher speed facility. Agreed that the protection level needs to be improved due to the vulnerability of the path users	
Action taken		

3.1.7 General – Conflicts/Omissions with Committed Expressway works in Progress

Minor

The Drawings appear to advocate a number of safety barrier works which appear to be in conflict with carriageway and safety barrier installations associated with committed works for the Rangiriri Section and Huntly Section. In particular:

- The proposed works through the Ohinewai Section north of Station 2.25 is nearing completion.
- The proposed safety Improvement works does not appear to be consistent with proposed four laning works, and
- The proposed works through the Ohinewai Section south of Station 9.30 is not consistent with proposed four laning works currently under construction.
- No improvement works are proposed through the Ngaruawahia Section north of Station 0.7 i.e. no proposed safety barrier works along the southbound onramp from Taupiri and the adjacent southbound onramp from Gordonton direction.

Recommendation(s)

Consider acquiring proposed works for the Rangiriri Section and Huntly Section and dovetail safety improvement works into and/or over and above committed works.

Further, given that Huntly works could be completed sometime after the safety improvement works (programmed for Year 2021), consider an interim treatment recognising the current (and/or future) constraints of the temporary construction works on the network until such works are complete.

Frequency Crashes are likely to be occasional	Severity Death or serious injury is unlikely	Rating The safety concern is minor
Designer response	The designer is in the process of attaining the designs for the Rangiriri and Huntly sections of the expressway. The design will be amended prior to IFC issue (expected in 2017) to provide continuity throughout the entire expressway when these are received.	
Safety Engineer comment	Agree that design consistency design between the sections is important and confirm that the designers approach is acceptable.	
Client decision		
Action taken		

3.1.8 General – Maintenance Access Bay Conflicts

Minor

The Drawings appear to advocate a number of maintenance access bay works which appear to be in conflict with the existing formation. In particular:

- Ohinewai Section – Station 7.98 RHS: The leading end of the parallel guardrail (W-section) and surrounding sealed access-way appears to conflict with the western approach fill embankment to Tahuna Road Overbridge.
- Ngaruawahia Section – Station 4.17 LHS: The leading end of the parallel guardrail (W-section) and surrounding sealed access-way appears to conflict an existing drain and headwall.

Not addressing these conflicts now may result in placing maintenance operators at further risk whilst undertaking maintenance operations where it is unsafe to do so and/or place expressway through movements at risk if maintenance operators are forced to undertake maintenance duties from the adjacent shoulder. This is a Safety In Design (SID) element which requires to be addressed.

Recommendation(s)

Consider the following improvements:

- Investigate relocating opening further north to avoid embankment conflict,
- Investigate relocating opening further north to avoid drain/headwall conflict.

Frequency Crashes are likely to be infrequent	Severity Death or serious injury is unlikely	Rating The safety concern is minor
Designer response	Detailed topographical surveys have not been undertaken on this project. Best efforts have been made to locate the proposed Maintenance Access Bays in an appropriate location. Notes have been added to the drawings such that the detailed locations of the Maintenance Access Bays are to be set out and confirmed with the engineer on site during the construction process. The designer has reviewed these locations and moved the Ohinewai maintenance bay approx. 15m north as recommended. The Ngaruawahia maintenance access bay is to be moved south to provide regular spacing between access bays and to better suit the topography.	
Safety Engineer comment	Agree that the maintenance bays should be relocated to avoid the identified conflicts. . Maintenance bays need to be carefully located as they are also used for speed cameras so there is also a need to provide and maintain sight lines.	

Frequency Crashes are likely to be infrequent	Severity Death or serious injury is unlikely	Rating The safety concern is minor
Client decision		
Action taken		

3.1.9 Ngaruawahia Section – Deficiencies associated with Future Proofing Hamilton Section Integration

Moderate

The Drawings appear to highlight a number of deficiencies associated with locating the proposed safety barrier in relation to the future Hamilton Section connection. They are as follows:

- The proposed WRB location is based on the ultimate arrangement of the Hamilton Section. However, there is no setting out to assist with determining the barrier alignment as offsets are based on future edge-line locations. There is a risk that the Contractor may incorrectly interpret these locations resulting in constraining current minimum safe stopping sight distances (SSD) afforded along the existing alignment, or, increasing the risk that the future alignment may require those barriers to be relocated once again.
- Existing barrier between Station 5.75 and 5.85 LHS has been incorrectly labelled as WRB. The actual barrier system consists of a W-Section arrangement.
- Existing rigid barrier terminating at Station 5.89 LHS illustrates a transition into a proposed WRB. This transition cannot be achieved as shown
- The proposed WRB between Station 6.43 to 6.51 appears to be located closer than 3m from the existing edge-line (measures 1m at the closest point). The proposed location will adversely affect forward SSD, is located with the current shy-line and will catch some drivers out should they require to use the shoulder for breakdown or other purposes.
- The existing median WRB between Station 6.35 and 0.06 has been incorrectly located. Consequently, the proposed barrier tie-ins are incorrect and will pose a hazard to vehicles if constructed as shown.
- The current wide shoulder along the northbound lane, between Station 6.1 and 0.6, is used by NZ Police for enforcement purposes. The Safety Audit Team are unsure what provision has been made along this section of the expressway. Future provision ensures that NZ Police are able to continue with enforcement including checking HCV's and their loads. The location should be relatively future proofed recognising a Hamilton Section connection at this point. Refer to Photo 1.
- The northbound mainline (north of Lake Road Overbridge) consists of dual lanes and appears to formalise a wide shoulder on the RHS by retrofitting a WRB some distance from the median edge-line. The wide shoulder may encourage vehicles to pull off to the RHS as opposed to the preferred and more natural LHS. Vehicles on the RHS through lane generally travel faster than the LHS. A vehicle accelerating from the RHS at a relatively slower speed may surprise through movements. This may result in through vehicles being forced to adjust speed and position to accommodate those slower vehicles. It's also important to note that the trailing end of the proposed median WRB proposes to cross the northbound lane connection from the Hamilton Section. This length could be reduced moderately to avoid rework associated with the Hamilton Section tie-in works.

Photo 1: Police checking HCV's

Recommendation(s)

Consider the following improvements:

- Provide set-out information for new safety barriers through future Hamilton Connection area,
- Ensure trailing end of proposed WRB on the northern side is appropriately lapped in front of the existing W-section barrier,
- Ensure leading end of proposed WRB is appropriately lapped behind existing rigid barrier,
- Ensure that the proposed WRB is located 3m minimum from the existing edge-line,
- Review existing median barrier location and extend new WRB ensuring connectivity is maintained.
- Review the need for shoulder space to be assigned for current Police Enforcement activities through stakeholder consultation. If confirmed, ensure that the safety barrier system is optimally located to future proof now, and, is located away from conflict points such as interchanges with ample forward and rear sight distance.
- Review the need for a wide shoulder along the RHS and reconfirm proposed WRB trailing end terminal location.

Frequency	Severity	Rating
Crashes are likely to be common	Death or serious injury is unlikely	The safety concern is moderate
Designer response	1. Set out information will be provided to the contractor in electronic format where appropriate and via detail drawings and notes on the General Arrangement plans. Much of the lateral barrier set out is fixed from off sets from existing edge lines and existing barrier terminals. The general location of new barrier features such as maintenance accesses are shown on the aerial photograph General Arrangement plans but it is expected that these locations are to be set out and confirmed with the engineer on site during the construction process. 2. The existing barrier has been amended to show W-section. Transition details have been updated accordingly. 3. The drawings have been amended to show a Type C Transition 4The barriers are shown 3.0m offset from future edge line. 5. Barriers in this location will be relocated during construction of the Hamilton	

Frequency Crashes are likely to be common	Severity Death or serious injury is unlikely	Rating The safety concern is moderate
	Section 6. The designer disagrees with these locations being used for police checks - the photo shows non-compliant police activity (the police should sit nearer to the lane than a vehicle he has stopped). The existing wide shoulder in this location is to accommodate the future Hamilton Section tie in. NZTA to confirm that HCV checks are not a recommended practice on the Expressway and provision is/will be provided elsewhere. 7. The existing safe hit posts will remain until the construction of the Hamilton Section to delineate the shoulder and discourage vehicles pulling off. The WRB is installed in this location (though it will be relocated/removed in the future in order to provide continuous edge barrier protection.	
Safety Engineer comment	1-5. Agree with designer comments relating to provision of electronic setout data and minor changes to drawings. 6 The Transport Agency should discuss appropriate enforcement locations with Police looking at the whole of the Expressway to ensure that Police can safety stop vehicles when required. 7. Agree that vehicles should be discouraged from parking on RHS shoulder through provision of safe hit posts.	
Client decision	Much of the edge protection provision in this area is under review as part of the detailed design of the Hamilton Section. The Agency is an active member of that alliance and will ensure fitness for purpose. Police should not be carrying out heavy vehicle enforcement on an unprotected shoulder and this will be rectified as part of the Weigh Right project. The installation of safe hit posts on the median shoulder is not agreed as these are considered unnecessary and can also impede sight distance.	
Action taken		

3.1.10 General – OGPA Conflict with Cyclists

Significant

Drawing C2901 appears to be advocating a variable OGPA surfacing shoulder width (varying between 2.1m and 2.5m. Given that Ohinewai and Rangiriri Sections advocate a 1m wide painted shoulder bar separation between the roadside trafficable lane and the shoulder assigned to cyclists, the OGPA lip will be located in the centre of the shoulder available to the cyclist. Consequently this will present a hazard to cyclists.

Recommendation(s)

Consider consistency across all sections of the expressway in terms of pavement marking and application of OGPA on the shoulder. A desirable outcome is OGPA surfacing extended to the face of the roadside barrier (or extend 2.5m absolute minimum from the adjacent roadside edge-line).

Frequency Crashes are likely to be common	Severity Death or serious injury is likely	Rating The safety concern is significant
Designer response	The designer notes that the drawings were unclear with respect to the installation of OGPA. OGPA is only to be extended where OGPA is already installed (Ngaruawahia and Te Rapa). There will be no extension of OGPA to affect cyclists on the Ohinewai Section as this section does not have OGPA surfacing installed.	

Frequency Crashes are likely to be common	Severity Death or serious injury is likely	Rating The safety concern is significant
	Typical details have since been amended to show OGPA to be extended to 300mm from the face of barrier where required.	
Safety Engineer comment	Cyclist safety is important and the providing OGPA to 300mm from face of barrier is supported. It is understood that the Cambridge Section will have OGPA applied this season, it is desirable that this approach (OGPA to 300mm from face) is taken when surfacing this section now to minimise the number of seal joints and potential rework.	
Client decision	Agreed that where OGPA is installed it is required to be continuous to end 500mm from the barrier.	
Action taken		

3.1.11 General – Various Safety Barrier Deficiencies

Minor

The Drawings appear to highlight a number of safety barrier deficiencies. They are as follows:

- A number of locations appear to locate the proposed safety barrier significantly beyond 3m from the adjacent roadside edge-line. This is in conflict with the details illustrated under Drawing No. C2901 and C2092 which states a 3m offset to be observed. The following are a few examples (but not an exhaustive list):
  - Te Rapa Section – Mainline: On approach and downstream of SH 39 Interchange in each direction.
  - Te Rapa Section – Te Rapa Road Southbound On-ramp.
  - Te Rapa Section – Northbound Lane between Onramp and Te Rapa Road Overbridge
  - Ngaruawahia Section – Te Rapa Road Northbound On-ramp.
  - Ngaruawahia Section – Mainline Station 1.83 to 2.02 LHS.
  - Ngaruawahia Section – SH 1B Northbound Off-ramp.
- A number of locations appear to adopt an existing safety barrier closer than 3m from the adjacent roadside edge-line. Continuous shoulder widths less than 3m may have safety implications for on-road cyclists, breakdown vehicles and forward sight distance. The following is one example:
  - Te Rapa Section – Station 1.70 to 1.85 RHS: Existing WRB located 2m from the adjacent roadside edge-line
- A number of existing median rigid barriers within the Ngaruawahia Section have no leading end terminals. These terminals are located in close proximity to the existing median WRB and are primarily installed to protect existing bridge piers within the median. Although shielded on approach by a WRB, there is still a latent risk that an errant vehicle strike under WRB dynamic deflection will result in rigid barrier contact and result in occupant harm. The Safety Audit Team recognises that the proposed project works do not further aggravate the current situation.

Recommendation(s)

Consider the following remedial measures:

- If the design intent is to locate the proposed barrier system beyond 3m from the adjacent roadside edge-line, then sufficient set-out should be provided by the designer to ensure that the contractor set-out is consistent with the designer's intentions and all doubt is removed.
- Review the need to modify existing barrier systems where the lateral offset is less than desired.
- Consider retrofitting the leading end of the median rigid barriers with a compliant terminal.

Frequency Crashes are likely to be infrequent	Severity Death or serious injury is unlikely	Rating The safety concern is minor
Designer response	1. The designer notes that in some locations the aerial imagery is not completely accurate and out of date. The drawings have been amended to show as accurately as possible the location of the barriers on the GA plans. The Typical Barrier Details drawings all clearly indicate the new edge barriers are to be located 3.0m minimum from the existing edge line. 2. The designer notes the comment of the SAT. Relocating existing barriers is outside the agreed scope of the project and these barriers (typically 2.8-2.9m offset) are not expected to pose a significant safety risk to justify changing the scope of the project. Where necessary, the taper to existing barriers will be compliant with manufacturers and NZTA requirements. 3. The designer notes the SAT comments. This is outside the agreed scope of the Project and the existing median barrier will remain in its current arrangement.	
Safety Engineer comment	1. Agreed that typical details should be relied upon and show new edge barriers 3m from edge line. 2. As the offset is 2.8-2.9m we agree there does not appear to be a significant risk from barriers remaining in their current location provided the necessary changes to tapers are compliant. 3. The existing median barrier terminal should be upgraded to provide a consistent level of safety service along this strategic corridor.	
Client decision	Agreed. While 2.8 – 2.9m offset to existing barriers may be acceptable. Offsets and location of all barriers must be confirmed on site and installed at the most appropriate offset. Upgrading the existing median barrier is not agreed as part of this project.	
Action taken		

3.2 Safer Speed Classification

3.2.1 General - Forward Sight Distance Deficiencies

Moderate

The Safety Audit Team has noted that with a lift in the posted speed limit, the 85%ile speeds correspondingly increase. The proposed safety barriers are currently located to account for Stopping Sight Distances, and merge/diverge sight distances at lane drops/gains and all off/on-ramps based on a prevailing Design Speed = 110km/h. These sight distances are in place to ensure that a normally alert driver, travelling at the design speed on wet pavement, perceives and reacts (and brake before reaching a hazard in case of SSD) accordingly.

The high risk areas are where critical sight distances associated with a change of environment occurs i.e. interchanges and at lane gains/drops.

Recommendation(s)

Consider the following remedial improvements:

- Review all proposed safety barrier offsets ensuring minimum critical sight distances are achieved on the basis of a DS=120km/h (posted speed plus 10km/h).
- Review existing safety barriers and ensure that there is sufficient sight distance and lateral width to manoeuvre if required to avoid a hazard.

Frequency Crashes are likely to be common	Severity Death or serious injury is unlikely	Rating The safety concern is moderate
Designer response	Graham Taylor from NZTA National Office has indicated to the design team that they are comfortable with a 210m SSD for the speed increase areas. Any discrete areas where 210m SSD is not available, vehicle tail light height should be considered as the object height. There are 3 discrete areas where the adopted 210m SSD has been compromised by the installation of new edge barriers; 1. Ohinewai Sector; The northbound horizontal curve at the northern end of the sector between RP 3.2 and RP 2.85 has a minimum SSD of about 180m with a 3.0m barrier offset. A barrier offset of about 4.75m from the edge line would be required in this location to provide for 210m SSD. It may be possible to trim back the existing flax bushes glare screen at the edge of the northbound carriageway in this location and attain a 4 to 5m barrier offset on the inside of the curve. Notes will be added to the drawings for the contractor to optimise the barrier offset in this location within the existing physical constraints. 2.Ngaruawahia Sector; There are 2 lengths of carriageway on the Ngaruawahia Sector that will have less than 210m SSD with the addition of new edge barriers. These are the existing direct ramps at the future connection with the WEX Hamilton Bypass project. In the southbound direction the SSD deficiency is at the right hand side of the 720m radius curve which crosses over the future WEX Hamilton carriageway on a bridge structure with a 3.0m shoulder width to the bridge and approaches barriers. The approach barriers are at the edge of a high fill embankment so there is little scope to increase the lateral offset without major earthworks and the barrier offset on the bridge cannot be improved without widening the bridge. In the northbound direction the SSD deficiency is on the left side of the 720m radius left hand curve adjacent to the future WEX Hamilton connection. There does appear to be sufficient berm width in this location to position the edge barrier approx. 7.5m from the northbound left side edge line to achieve the 210m SSD. The drawings will be amended to show the increased off-set.	
Safety Engineer comment	1. Agreed that barrier location should be optimised on site through vegetation trimming as proposed by designer 2. While desirable to improve SSD it is acknowledged that the existing constraints make this difficult. As noted by the designer, National Office recognise that vehicle tail lights can be considered as object height. Designer to confirm the available SSD at these locations with tail light as object height Proposed barrier in northbound direction should be relocated to achieve at least 210m SSD as proposed by designer.	
Client decision	Where 210m SSD cannot realistically be provided, please advise what can realistically be achieved a. For a 1.1m height of eye to 0.2m object b. For a 1.1m height of eye to a 0.8m high brake light Please also advise the available seal width for manoeuvring should we need to apply Section 5.5.1 of AGRD Part 3 on the system ramps at the WEX Hamilton connection.	

Frequency Crashes are likely to be common	Severity Death or serious injury is unlikely	Rating The safety concern is moderate
Action taken		

3.2.2 General - Acceleration Distances on On-ramps

Moderate

The Safety Audit Team has noted that acceleration distances are required to increase as a result of lifting the expressway posted speed from 100km/h to 110km/h. The magnitude in additional acceleration length is greatest where Interchange onramp lengths are short, ascending and compounded further where there is a high proportion of HCV's.

By far the greatest affect are slower merging traffic into the LHS through lane adjacent to on-ramps. If the differential speed is greater than 10 km/h, through traffic are forced to weave into the adjacent lane to avoid the merging traffic. The weaving increases the risk for the LHS lane vehicle to interact with either the adjacent RHS through lane or the merging traffic from the left.

The Safety Audit Team requests that all Onramp lengths are checked. In particular, the Safety Audit Team has identified the following on-ramps presenting the greatest potential for differential merge speeds:

- Rangiriri Southbound On-ramp
- Great South Road Northbound On-ramp

Recommendation(s)

Review onramp lengths and ensure that ramp lengths do not encourage merge speeds with greater than 10 km/h differential.

Frequency Crashes are likely to be common	Severity Death or serious injury is unlikely	Rating The safety concern is moderate
Designer response	The Rangiriri Southbound On-ramp, while it is included in the speed increase, is currently under construction by others and is beyond the physical works scope of this Project. The Ohinewai to Te Rapa sectors include interchanges with on-ramps at Ohinewai, SH18 Gordonton Road, Te Rapa Rd and Koura Drive. The lengths of the ramps from the terminal intersection to the start of the 2% merge taper ranges from 300m to 430m. The ramps are all on downhill grades and the mainline grades beyond the ramp nose are generally flat with the exception of the Te Rapa southbound on-ramp taper which is on a maximum uphill grade of about 1% . In all cases the merge tapers are at least 265m long and all on-ramp configurations are in compliance with the Standard Motorway and Expressway Exits and Entrances……. diagram, Figure 2.6A as shown in Motsam Part 3: Motorways and Expressways. With an assumed entry speed of say 30km/hr, on a 3 to 4% down grade the length required for a car to achieve a speed of 110 km/hr is about 350m. In all cases, with ramp lengths noted above, this distance can be achieved either prior to or within the merge taper area. Austroads GRD Part 4C states that 'It is often impractical to provide very long entry ramps and hence they should generally be in the range of 300m to 450m'. In general all the on-ramps lengths and configurations, within the agreed scope of works, comply with the current standards.	

Frequency Crashes are likely to be common	Severity Death or serious injury is unlikely	Rating The safety concern is moderate
	It is anticipated that NZTA National Office will reconfirm any design interfaces between the Key Corridor Safety Retrofit Programme and projects currently in construction once we have more certainty on the Key Corridor implementation programme.	
Safety Engineer comment	Where on-ramps are shorter than 350m, the edge barrier should be located to provide wider shoulders allowing additional space if conflict occurs between merging vehicles. This will require that the carriageway surfacing extends up to the barrier face, this may require changes to the typical details	
Client decision	Widening of the shoulder changes the ramp configuration and is not an acceptable option. With the large number of trucks in the vehicle stream we will have a 20km/h speed differential. In our experience, many cars enter the motorway at about 80km/h presumably due to motorist confidence levels. Given the relatively low volumes on the expressway it is considered that there is ample opportunity for faster vehicles to change lanes.	
Action taken		

3.2.3 General - Various Sign Deficiencies

Minor

The following sign deficiencies were observed:

- General - In many locations, large speed threshold signage is proposed to be installed within the median i.e. Rangiriri Station 15,320m etc. Given that wind loading is likely to be a significant factor in the design of the sign support system, the post may not be frangible in nature. If the post support is indeed a shear based system, the post may dislodge on impact and become a potential hazard.
- Rangiriri Section - The advanced warning speed limit signs at Station 15,150m (northbound) may be obscured by the Bridge piers/abutments.
- Cambridge Section – 100km/h speed threshold signage along the Southbound Onramp to Cambridge West has been omitted.
- Ngaruawahia Section – the advanced warning “80 km/h” speed threshold signs at Station 1.86 lack in appropriate sizing.
- General – the proposed 110 km/h speed threshold signs at Station 4.71 (Te Rapa Section – northbound) and at Station 0.73 (Ngaruawahia Section – southbound) are located at or near areas where further decisions are required to support a change of environment ahead i.e. diverge from single lane to dual lane etc. Imposing multiple decision making at these locations may confuse some drivers. A desirable outcome is to separate these decisions further.

Recommendation(s)

Consider the following improvements:

- Consider the following:
  - Install additional median barrier protection to prevent vehicle interaction with threshold signage in the median.
  - Undertake sign post design now to confirm requirements to support the sign panel at the outset. This ensures that the contractor is not in a position to install a sign support which might be detrimental to the outcome of a vehicle interacting with median signage.

- Relocate advanced warning signs prior to Te Kauwhata Over-bridge.
- Install additional speed threshold signage for off-ramps in question.
- Ensure that signing consistency and conspicuity is achieved by installing a 900x900 minimum diamond plate size.
- Relocate threshold signage to four seconds beyond the commencement of dual lanes.

Frequency **Crashes are likely to be infrequent**	**Severity** **Death or serious injury is very unlikely**	**Rating** **The safety concern is minor**
Designer response	Large threshold signs are shown in the median near the Te Kauwhata southbound Off-ramp, near Lumsden and Balemi Rd, either side of Kainui Rd, and south of Tamahere. In these locations the median is 9m or wider and similar signs (which we will replace or relocate) have already been installed in these locations. The constructor will be required to install frangible posts in accordance with the RSMA Compliance Standard for Traffic Signs. Similar sized signs have been installed with frangible bases at the south end of the Te Rapa section. Installing effective additional barrier protection around the signs will introduce a new hazard to the median and significantly reduce the clear median width over a reasonable length when compared to the point hazard of the sign. Installing frangible sign bases will mean the sign represents a minor hazard. This would mean the benefits and dis-benefits of installing additional barrier protection would be significantly out of proportion to level of hazard the median signs represent. The warning signs at Te Kauwhata Road for northbound traffic are shown south of the Te Kauwhata Road bridge. 100km/h off-ramp signage is now shown on the Southbound Offramp to Cambridge West. All warning signs are the large 1200x1200mm diamonds (or 900x900mm squares). The 110kph speed signage located at the north end of the Ngaruawahia Section, there is no driver decision. The on-ramp forms a lane gain to the single lane to the single lane main carriageway well in advance (600m approx.) of the two lanes meeting. This also avoids any short lengths of 100kph. The 110kph speed signage at the south end of Te Rapa is located at the commencement of the two lanes on the expressway. The choice of one of two parallel lanes is considered a minor decision which doesn't involve conflicting movements and hence a minor risk..	
Safety Engineer comment	Accept signs located in 9m wide medians without additional barriers as minor hazard provided bases and poles are frangible. Accept proposed layout at northern end of Ngaruawahia section as it avoids multiple speed limits and is in advance of lane gain arrangement. The location of the current temporary 80km/h speed limit on the Te Rapa section is being reviewed. Designer to liaise with NZTA staff (Mike Pilgrim) to ensure that the current review aligns with the location for the proposed 110/80km/h speed limit change. Prefer that the location is downstream of the dual lanes commencing.	
Client decision	Designer response and Safety Engineer comments agreed	
Action taken		

4 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 6/09/2016

s 9(2)(a)

Principal Transportation Engineer, MWH New Zealand Ltd, Hamilton

Signed s 9(2)(a) Date 6/09/3016

s 9(2)(a)

Principal – Road Safety, Opus International Consultants Ltd

5 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.

5.1 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]

5.2 Safety Engineer's Comments (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]

5.3 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]

5.4 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]

5.5 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: .....

Appendix A Drawings Audited