



Fulton Hogan-HEB Waikato
Expressway Huntly Section:
Detailed Design

Signs, Markings, Barriers and
Lighting Package: Detailed Design
Stage
Road Safety Audit Report

December 2015

Released under the Official Information Act 1982



Fulton Hogan-HEB Waikato Expressway
Huntly Section: Detailed Design

Signs, Markings, Barriers and Lighting
Package: Detailed Design Stage
Road Safety Audit Report

Quality Assurance Statement

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1. Background

1.1 Safety Audit Procedure

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, that is, minimisation 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 in order that the client can make a value judgement as to appropriate action(s) based on the risk guidance provided by the safety audit team.

The key objective of a 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);
- Detailed Design Stage (Pre-implementation / Implementation); and
- Pre-Opening / Post-Construction Stage (Implementation / Post-Implementation).

A road safety audit is not intended as a technical or financial audit and does not substitute for a design check on standards or guidelines. Any recommended treatment of an identified safety concern is intended to be indicative only, and to focus the 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 Guideline”, 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 shall 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 to be completed by the designer, safety engineer and client for each issue documenting the designer response, client 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 Safety Audit Team

The road safety audit was carried out in accordance with the "NZTA Road Safety Audit Procedure for Projects Guideline – Interim Release May 2013", by the following Safety Audit Team (SAT):

- s 9(2)(a) Technical Director, TDG Tauranga;
- , Senior Consultant, Traffic Planning Consultants, Auckland; and
- , Principal Transportation Engineer, MWH, Auckland.

The safety audit team undertook the audit on Wednesday 9 December 2015 at the FH-HEB Huntly Site Office on McVie Road, Huntly. A briefing meeting led by s 9(2)(a) (Design Manager), was first held followed by a desk-top analysis. A final de-briefing at the end of the day was attended by the same members of the project team.

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 Matrix in Table 1 below.

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

Severity (Likelihood of Death or Serious Injury Consequence)	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

Table 1: Concern Assessment Matrix

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 2** below.

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

Table 2: Concern Categories

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 Scope of Audit

This is a Detailed Design Stage Road Safety Audit of the Signs, Markings, Barriers and Lighting Design package for the Huntly Section of the Waikato Expressway prepared by the Fulton Hogan /HEB /Opus /Jacobs /Gaia /Bartley project team. The lead designers for the project are Opus/Jacobs.

It is emphasized that 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. The SAT has focussed on areas of general concept as opposed to a detailed inspection of each element. Hence omission of a comment or concern on an issue in this report does not imply approval of any particular detail. Further safety audits will be carried out of the detailed design of other elements which may have some interdependency on geometry, and therefore may raise issues not already noted at this stage.

Three previous Road Safety Audits have been prepared for this project: a Scheme Stage Audit (dated 7 September 2011), a Specimen Design Stage Safety Audit (dated 10 October

2012) and a Tender Concept Stage Audit (FH-HEB dated 3 November 2014). Where an NZTA decision has been made on an issue raised in earlier audits it has not been repeated unless the SAT wish to further highlight a particular issue, or where the issue does not appear to have been satisfactorily closed off. The SAT highlight that this means agreed actions from previous audits need to be tracked and completed.

The Detailed Design is understood to comply with the Principal's Requirements for the project except where specifically identified otherwise in the Stage 2 85% Design Reports for Signs and Markings, Barriers, Lighting and ATMS. This audit is to be read in conjunction with the earlier design package audit for Geometrics dated October 2015.

1.5 Documents Provided

The SAT has been provided with the following documents for this audit:

- Fulton Hogan/HEB/Opus/Jacobs/Gaia/Bartley Design Reports, Stage 2 85% Design for:
 - ◆ Signage and Pavement Marking (Rev B – 17 November 2015) incorporating drawings DG- R- 4001 – 4036 Rev B, 4040 Rev A, 4060 Rev B, 4051- 4053 Rev B;
 - ◆ Roadside Safety Barriers (Rev B – 31 November 2015) incorporating drawings DG – R - 4101 – 4136 Rev B, 4150 – 4162 Rev A/B;
 - ◆ Road Lighting (Rev C – 1 December 2015) incorporating drawings DG – R – 4301, 4302,4311 – 4320, 4331 – 4340, 4351 – 4353, 4355- 4357, 4361 – 4362 all Rev A;
 - ◆ ATMS Infrastructure (Rev B – 29 October 2015) incorporating drawings DG – R - 4401 – 4436 and 4450 all Rev A.

1.6 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 or 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.

1.7 Project Description and Context

The SH1 Waikato Expressway Huntly Section is a 15.5km length of four-lane expressway which runs from the existing Ohinewai four lane section in the north to the recently completed Ngaruawahia Section in the south.

The alignment traverses steep undulating terrain and climbs over 75m to its highest point before dropping approximately the same amount. It is understood the Principal's Requirements have called for a 110km/h design speed throughout the mainline, a maximum grade of 4.5% (on the flat) and horizontal curves of 720m minimum radius.

Two grade-separated interchanges are proposed, one at each end of the project: the northern end has north facing ramps only while the southern end has a full diamond interchange at Gordonton Road. The southern grade-separated interchange has a twin roundabout dog-bone layout which has been previously audited as part of the Ngaruawahia Section and this project nominally terminates at the north facing ramp connections to the dog-bone roundabouts.

Traffic to/from Huntly will need to use either of the interchanges at each end of the project. Southbound traffic from Huntly will need to use the Gordonton Road interchange.

Two local road severances are proposed: one at Fisher Road and a second at Kimihia Road although the latter road is not formed to public road standard and is currently closed to the public. Grade-separated overbridges are proposed at Ralph Road, McVie Road, Orini Road and Waring Road.

Departures from the Principal's Requirements (PR's) that were noted by the designers (design report section 3.6) to have been accepted are limited to:

- Gordonton Interchange Off-ramp use of 310m SISD to diverge ramp nose pavement level;
- Gordonton Interchange On-ramp amended configuration which includes an auxiliary lane.
- Back support width behind barriers reduced to 0.6m;
- Aquaplaning depths of over 6mm have been accepted in three areas and design approach has been accepted which includes increasing the pavement rate of rotation to 3.5%/s.

It is understood from the project briefing by the designers that the design is compliant with appropriate standards except where departures have been agreed with the NZTA.

2. Safety Audit Findings

2.1 Lighting

2.1.1 Northern Tie-in

Comment

At the northern tie-in the proposed lighting design results in a sudden change in offset of the streetlight poles between the existing highway lighting and the proposed highway lighting. This will possibly result in an unpleasant appearance of alignment and /or width and while not likely to be a safety issue, the aesthetics could be improved.

Frequency Rating:	NA	Severity Rating:	NA
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Designer Response: *The proposed scheme has been designed to meet the lighting requirements without conflicting with other services or construction features. The existing lighting may have been subject to different requirements at the time of its construction and as such there may be a visual difference, or survey data may show a larger set back than actually present on site. Changing the proposed layout to match the existing would increase the set back and therefore require additional wattage or fittings to achieve compliance with AS/NZS 1158. I would therefore note the comment but recommend no change.*

Safety Engineer: *Needs a lighting specialist to check/review. Need to see plans. Ensure lighting outcomes won't lead cars to take a line that is misleading. Should be aiming for lighting consistency in terms of lamps, lighting outputs etc.*

Client Decision:

Action Taken:

2.1.2 Northern Interchange On-ramp

Comment

The lighting on the north interchange on-ramp is located on the inside of the horizontal curve. The SAT considers that the delineation and hence safety of the curve could be improved with the placement of the highway lighting around the outside of the on-ramp curve.

Frequency Rating:	NA	Severity Rating:	NA
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Designer Response: *It is noted and agreed that the preference is for lighting to be located on the outside of the bend to offer visual guidance to the road user. In this particular instance drainage and maintenance features prevent this from consistently being achieved and therefore a regular arrangement was preferred to a changing one. As such cable road crossings are mitigated against, which reduces future maintenance risk to the asset owner.*

Safety Engineer: *Need to discuss with Operations team as it was acknowledged that it*

would be better for the lighting to be located on the outside of the bend. I would like to better understand the maintenance team's requirements.

Client Decision:

Action Taken:

2.1.3 Mainline Single Sided Lighting

Comment

Single sided lighting is proposed on the mainline to the north of the lighting arrangement for the Gordonton Road Interchange. The SAT acknowledges the design report indication that a compliant design has been provided, but considers an additional check should be undertaken to ensure that the carriageway lighting for southbound traffic has satisfactory uniformity and the median barrier will not result in any shadowing of the traffic lane.

Frequency Rating: NA Severity Rating: NA

Designer Response: The lighting at this point is required only to cover the extent of the on ramp, the lighting does not illuminate both carriageways and only the North bound running lanes.

Safety Engineer: Has the designer actually answered the query about the risk of shadowing. Refer to earlier comments about a lighting specialist to review lighting details.

Client Decision:

Action Taken:

2.2 Signs and Markings

2.2.1 Southern Tie-in

Comment

The extent of the signs and marking of the proposed works extends beyond the "extent of work" nominally labelled on drawing 4036. Similarly, the physical works required also appear to extend beyond the extent indicated on the geometrics drawings previously provided. It is important that the scope of works in the area around the southern tie-in, including the ramp tie-in, is clarified to ensure that there is no element overlooked.

Frequency Rating: NA Severity Rating: NA

Designer Response: Comment noted. PRs A9.1.5 (below) requires signage to extend beyond the extent of works shown on the geometric drawings to fully integrate the Huntly Section to the existing Ngaruawahia Section.

"On the approaches, to the project new signs shall be installed and existing signs removed as required to fully integrate the new works with the existing road network. This shall include the following locations:

- On the northbound carriageway of the Ngaruawahia Section ahead of the Gordonton Road interchange;
- On the southbound carriageway of the Ohinewai Section ahead of the northern interchange;
- On the SH1B (Gordonton Road) approaches to the Gordonton Road Interchange from both directions and at the interchange roundabouts.”

This will be clarified within the 100% Signage and Pavement Marking design package to ensure the scope of works is clear and aligned with PR A9.1.5.

Safety Engineer: Accept designer's response.

Client Decision:

Action Taken:

2.2.2 Edge Markers

Comment

The Signs and Markings design report notes that edge marker posts are intended to be integrated into all barriers in unlit sections and reflectors mounted on top of all sections of wire rope barrier. However the SAT found no reference to these markers on the drawings.

The SAT highlights the importance of providing a continuous and uninterrupted night-time reflector delineation of all barriers (including concrete barriers) along the mainline.

Frequency Rating:

NA

Severity Rating:

NA

Designer Response: Thank you and noted. This has been amended in the final 100% design issue.

Safety Engineer: Accept designer will include all required reflectors and edge marker posts and update drawings accordingly.

Client Decision:

Action Taken:

2.2.3 Cyclists Crossing at Ramps

Moderate

Drawing 4060 shows typical cycle ramp treatment. The cycle crossing detail of the off-ramps (and to a lesser extent the on-ramps) shows the hold rail near parallel to the ramp carriageway. This would require cyclists to stop parallel to the ramp and look behind themselves over their shoulder to see oncoming traffic, which is difficult and may result in a cyclist not paying adequate care and overlooking an approaching vehicle. Additionally a cyclist stopped at the hold rail would need to make a near ninety degree turn to cross the ramp *after* deciding to accept a gap in traffic, which is more awkward and will result in slower crossing times.

Use of the marked off-ramp crossings is dependent on cyclists on the mainline observing the facility on the approaches to the off-ramp gore area. A cyclist may not see the cycle

crossing sign located approximately 120m up the ramp and continue directly across the throat of the ramp taper. Additional guidance could be considered to delineating the appropriate route a cyclist should take using either signage or green pavement marking or a combination.

Recommendations:

1. Position cycle hold rail perpendicular to the ramp carriageway and alter markings accordingly;
2. Provide additional guide delineation for cyclists near the start of the ramp taper to guide them to the formed ramp crossing.

Frequency Rating:	Infrequent	Severity Rating:	Likely
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Designer Response: The design has been updated to provide a hold rail as perpendicular as possible (less than 45degrees normal to the ramp) in the shoulder width available.

We have adopted the SAT team's advice to provide additional delineation near the start of the ramp taper. In the form of green paint, IG-21 "Use Ramp" sign and cyclist symbols within the shoulder, approximately 20m before the start of the off-ramp continuing up the ramp for approximately 25m (45m in total). This encourages cyclists to follow the cycle lane to the designated crossing instead of crossing along the continuity lines.

Safety Engineer: Accept designers response to incorporate SAT's recommendations.

Client Decision:

Action Taken:

2.2.4 North Interchange – Off-ramp Speed Sign

Minor

The *Expressway Ends* sign on the southbound off-ramp includes a 100km/h speed restriction sign. However, as the posted speed is not changing, there is no need for the 100km/h sign and drivers should not be encouraged to travel at higher speeds. If the posted speed of the old alignment should be reduced in the future then a sign could be installed at that time and if necessary consideration could be given within the sign for future proofing.

Recommendation:

Remove the 100km/h posted speed from the off-ramp expressway ends sign.

Frequency Rating:	Infrequent	Severity Rating:	Unlikely
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Designer Response: Recommendation adopted and has been included in the final 100% design.

Safety Engineer: Accept removal of 100km/h speed limit sign at this location.

Client Decision:

Action Taken:

2.2.5 North Interchange – Waikato Expressway Signs

Minor

The *Waikato Expressway* sign on the northbound on-ramp is located about 250m from the commencement of the ramp. By the time drivers see the sign it is too late to change their route and they will remain on the expressway unless they decide to stop on the ramp or make other ill-advised manoeuvres. Relocation of the expressway sign back to the start of the ramp will better define the start of the ramp and allow drivers to stop in advance should they decide to.

Recommendation:

Move the Waikato Expressway sign to the start of the ramp where it can be seen from the two way approach highway.

Frequency Rating: **Infrequent** Severity Rating: **Unlikely**

Designer Response: *Recommendation adopted - the Waikato Expressway sign has been moved approximately 200m back to the ramp diverge in the final 100% design issue.*

Safety Engineer: *Accept designers response to relocate the expressway sign.*

Client Decision:

Action Taken:

2.2.6 North Interchange – Advanced Waikato Expressway Sign

Comment

The advanced *Waikato Expressway* sign (2km in advance) of the northbound on-ramp is useful in informing a driver of the expressway ahead and the intent of the supplementary message is appropriate and understood by the SAT, but may not be clear to all drivers. A nationally consistent sign message and format is easiest for a driver to understand. A typical format for ADS or confirmation signage would be the state highway shield coupled with the cardinal “north” direction as shown for example on sign 4001-NB-3. Using this format inclusion of the “north” direction in the body of the sign supplemented with the “only” below may be more readily understood.

Frequency Rating: **NA** Severity Rating: **NA**

Designer Response: *Comment noted. This has been amended in the final 100% design issue with the cardinal “north” at the top of the sign and “only” in yellow at the bottom, in accordance with TCD Manual Part 10 Section 3.1.*

Safety Engineer: *Accept designer’s response to amend sign detail.*

Client Decision:

Action Taken:

2.2.7 Northern Existing Highway Interface- Median

Minor

Drawing 4003 indicatively shows a flush median extending back from the highway ramp diverge to the existing pavement with “keep left” arrows within the flush median. The drawing refers to Figure 2.9 (b) of MOTSAM part 2 and shows the flush median extending to the existing markings. There are no dimensions of the flush median and taper widths although the designers advised at the termination of the wire rope barrier the median width would be 1.1m either side of the wire rope barrier.

Several concerns were identified in this area:

- Dimensions of the median should be shown to guide construction;
- The existing highway is marked as a yellow wide centreline treatment (WCLT) and therefore the tie-in needs to show the markings transitioning to the existing WCLT;
- The advised 1.1m shoulder width to the barrier terminal end is less than desirable for eliminating the shy line effect for the prevailing operating speeds of vehicles. While it is acknowledged that a “keep left” arrow is provided in advance of the barrier, the median width does not appear to be wide enough to accommodate the sign at the location shown. This sign will be vulnerable to impact (and similarly for the opposing traffic direction) and fragments of the sign could hit the windscreen of an opposing vehicle. The SAT also notes that the proposed RG17 size of 300mm is smaller than expected in a rural environment and will not be as prominent as a 600mm size which is the minimum recommended diameter.

Overall the design dimensions and colour of all signs and markings between the barrier terminal end and the existing highway tie-in need to be clarified with the above concerns in mind. The SAT recommends that a physical island is considered in front of the wire rope barrier (with a traversable profile that is appropriate to location in front of a wire rope barrier) within which the rural sized RG17 arrow can be accommodated.

The SAT acknowledges that this recommendation would result in the removal of the keep left sign for southbound traffic, and in its place recommend consideration to gating of the PW6 two way signage coupled with the use of direction arrows on the pavement.

Recommendations:

1. Clarify the design dimensions and colour of all signs and markings of the flush median in front of the barrier and tie into the existing highway.
2. Provide an appropriately designed physical median in advance of the wire rope barrier to house the rural size keep left arrow.
3. Consider gating of the PW6 two way signage coupled with the use of direction arrows on the pavement.

Frequency Rating: **Infrequent** Severity Rating: **Very Unlikely**

Designer Response: We have adopted the SAT Team’s advice to clarify recommendation 1 in the 100% final design.

An appropriately designed physical island will be put in place to house the “Keep Left” arrow, gating of the PW6 two-way signage coupled with direction arrows will also be used

to guide drivers. This will be shown on the 100% final design drawings.

The final 100% design includes the tie-in to the existing yellow WCLT markings.

Safety Engineer: *Accept designer's response and recommended changes. Ensure drawings are updated.*

Client Decision:

Action Taken:

2.2.8 Intersection Chevron Boards

Comment

Chevron boards have been shown diagrammatically at the head of intersections with a note that height to be confirmed on site.

The SAT concur that on-site assessment is required and add that this should also include location of signage to ensure it is in the line of sight of approaching traffic.

Frequency Rating: NA **Severity Rating:** NA

Designer Response: *Agree and this has been added to the final 100% design package.*

Safety Engineer: *Accept designer's response.*

Client Decision:

Action Taken:

2.2.9 Evans Road Curve/End of Seal

Minor

Drawing 4012 shows a chevron board on the outside of the tight radius curve at the end of the road but does not show the proposed access to the gun club. The chevron board needs to be located on the line of site of approaching drivers which may need some adjustment of the access location to achieve.

Additionally, the proposed end of seal is located immediately following the curve, which obscures the commencement of the unsealed section; and while the end seal sign does provide some warning, a driver may still be surprised by the commencement of the unsealed section.

Recommendations:

1. *Ensure Evans Road chevron board on the curve is located within the drivers' line of sight.*
2. *Ensure there is adequate forward visibility to the end of seal appropriate to the expected operating speeds.*

Frequency Rating: Infrequent **Severity Rating:** Unlikely

Designer Response: Agree and the chevron board has been adjusted to within the drivers' line of sight for the 100% final issue.

The end of seal location, Gun Club entrance and the curve advisory speed 35km/h is a Principal's Requirement (PR) (A2.6.4). We propose this is assessed in the post construction road safety audit.

Safety Engineer: Accept designers response regarding chevron board location and height.

Review location of end of seal. If it should be extended, decide now and include on drawings.

Client Decision:

Action Taken:

2.2.10 Taupiri Reserve Access

Moderate

In addition to the significant concerns described in the previous geometrics package safety audit (which includes matters associated with signs and markings), the SAT has identified some additional issues.

- The proposed merge sign at the end of the acceleration lane (Drawing 4025) depicts 2 lanes to 1 and should be 3 to 2 lanes;
- The arrow shown at the commencement of the acceleration lane may indicate the presence of a third lane to through traffic who may then use it as a passing lane;
- As discussed previously, the left turn lane may be confused as a third lane. To minimise this incorrect use and/or late manoeuvres, a solid line should be used between the through and left turn lane (in a similar fashion to the 100m length shown for a two lane drop exit in MOTSAM) and consideration could be given to additional signage clarifying the left lane use for exit only.
- At the end of the left turn lane the safe speed on the left turn will be very low and curve warning signage is essential particularly given a drivers expectations of a higher speed exit in the expressway environment. However the SAT are concerned that any curve warning signage may then be confusing to drivers on the mainline;
- The shoulder width is not dimensioned adjacent to the additional lanes but appears to be too narrow to safely accommodate a cyclist. Moreover there is no provision for cycle movements across the throat of the proposed access itself. If this proposed access is to be retained, provision for the safe passage of cyclists is necessary.
- At the end of the acceleration merge there is no allowance for a run-out zone such as typically provided at the end of a high speed merge (eg as for passing lanes). As a minimum it is recommended that the same combined shoulder/lane width is continued through from the start to end of the merge taper.

Overall, the SAT reiterates the significant concerns raised in this and previous audits with the recommendation to eliminate this access.

Recommendations:

Eliminate this access, but if it is to be retained then as a minimum:

1. Provide appropriate merge signage;
2. Reconsider need for arrow in acceleration lane;
3. Use a solid line between the through and left turn lane (in a similar fashion to the 100m length shown for a two lane drop exit in MOTSAM) and consideration could be given to additional signage clarifying the left lane use for exit only.
4. Add curve warning signage on the left turn exit without confusing drivers on the mainline;
5. Provide for safe passage of cyclists though the area including the exit and entry lanes;
6. Provide a run-out zone through the merge area.

Frequency Rating:

Occasional

Severity Rating:

Likely

Designer Response: We believe that there are a number of features to the prescribed DOC carpark design that could be adjusted to improve the facility. However, we note that these changes would require an alteration to the PR's and likely include a variation to the project costs. We have submitted an alternative layout design (see attached sketch) to the Principal's Advisor to see if these improvements can be incorporated, it includes:

1. Separation of the ingress/egress points with ramps to either end of the carpark, (i.e. removes the potential for right-turn movements at egress point).
2. A ramp arrangement is the appropriate layout for a high speed motorway environment. On and off ramps remove the third lane or passing lane effect, as described above by the SAT Team.
3. Cyclists follow the shoulder of the carpark off-ramp with a cyclist path around the carpark to connect to the on-ramp shoulder. Providing a safe route by removing the cyclist vs vehicle conflict, as no road crossings are required.

No further action proposed until a response is received from the Principal's Advisor regarding our proposed alternative layout.

Safety Engineer:

1. Provide appropriate merge signage.
2. Discuss further with Project Manager and James Hughes. I think there is a lot of risk with the original design. Tight curve at access, unexpected access facility from Expressway. This is a potential route for 110km/h speed environment. Is there an alternative way to access this facility rather than off the Expressway. I think we can do better. Recommend a review of this item.

Client Decision:

Action Taken:

2.2.11 Stokes Road Curves

Minor

There are two potentially out of context curves on Stokes Road that have no edge delineation in the form of edge marker posts, chevron boards nor curve warning signs, (drawings 4029 and 4030) which may result in loss of control crashes. The SAT acknowledges the road is a low volume road providing local farm access, however there will likely be visitors at times.

It is understood from the designers that the need for additional delineation or signage is to be considered on completion of the works, in which case the SAT considers this should be indicated on the drawings.

Recommendation:

Ensure that the intention to consider additional delineation and signage of Stokes Road curves is indicated on the drawings.

Frequency Rating: **Infrequent** Severity Rating: **Unlikely**

Designer Response: On further investigation edge marker posts have been added to the final 100% design for R185m curve (approximately Ch.145m-290m) and R90m curve (approximately Ch.665m-920m) in accordance with MOTSAM Part 2 Section 5.05, with Stokes Road meeting the minimum AADT of 100.

We have adopted the recommendation, for the 100% final design, to indicate on the drawings that a post construction safety audit is to be undertaken to reassess signage and delineation of Stokes Road.

Safety Engineer: I think decisions on what is required for signage and delineation should be made now. We shouldn't need to wait for a post construction safety audit. Agree with designer's response to install edge marker posts for out of context curves. Recommend other items of concern are addressed now.

Client Decision:

Action Taken:

2.2.12 Gore Area/Entrance Area Markings

Minor

The SAT considers that the safety of the project could be further improved through the inclusion of chevron markings though the gore areas and entrance areas to assist to guide drivers through these high risk areas. This is particularly useful on the gore areas of the off-ramps and more so on the outside of a curve such as at the northern interchange.

Recommendation:

Use chevron hatched marking in the gore area at each of the ramps.

Frequency Rating: **Occasional** Severity Rating: **Unlikely**

Designer Response: Accepted SAT team advice and chevron hatching has been added to the gore areas of each ramp.

Safety Engineer: Accept designer's response to include chevron hatching at gore areas of ramps. Ensure is shown on all pavement marking plans.

Client Decision:

Action Taken:

2.2.13 South Interchange – Off ramp Signage

Significant

The southern interchange southbound off-ramp includes a 'wrong way - go back' sign very close to the limit line of the roundabout circulatory lane. Signs so close to a corner can be easily missed by a driver and if so there is no other signage further down the ramp to alert the driver to his error. A 'no entry' sign should be used at the ramp termination clearly visible to drivers on the roundabout with gated 'wrong way – go back' signs further down the ramp with good forward visibility.

A similar situation is shown on the existing northbound off-ramp infrastructure. While this may be outside the scope of works the signage for this ramp should still be checked.

Recommendation:

Ensure off-ramps are well signed to prevent wrong way movements using, as a minimum, a combination of 'no entry' and 'wrong way – go back' gated signage.

Frequency Rating:	Occasional	Severity Rating:	Very Likely
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Designer Response: Accepted SAT advice, 'no entry' and 'wrong way – go back' signs have been adjusted in the 100% final design. 'no entry' gated signs have been added at the ramp entrance and gated 'wrong way - go back' signs further down the ramp for good visibility.

Safety Engineer: Accept designer's response. Ensure all signs are clearly marked on drawings.

Client Decision:

Action Taken:

2.2.14 South Interchange Southbound Off-ramp ADS

Minor

The southern interchange southbound off-ramp terminus roundabout has awkward geometry with legs at varying angles. An attempt has been made on the ADS map sign to mimic the layout, which has resulted in a confusing sign, particularly with the Gordonton Road overbridge, and the two ramp legs all within ninety degrees of each other.

Map signs do not have to mimic the roundabout layout faithfully, and should rather show the driver clearly which destinations relate to the first exit (LHS of sign), second exit (top of sign), and third exit (RHS of sign) from the roundabout.

The SAT is pleased to see that no attempt has been made to show successive roundabouts on one ADS map sign.

Simplify the ADS map signage layout to improve driver understanding of the destinations with respect to first, second, and third exits from the roundabouts.

Frequency Rating: **Occasional** Severity Rating: **Very Unlikely**

Designer Response: We believe a simplified representation of the roundabout layout is required to provide drivers' with expected exit angles (layout) and do not encounter an alternative. However, we do note that sign 4035-SB-7 was not clear and have adjusted the first and third exit to 90degree branches.

Safety Engineer: Recommendation: Agree to review signage. Can learn for Tauranga Eastern Link experiences. Talk to Adam Francis (Snr Safety Engineer Tga office) if need to. Safety team want to see revised signage layout before final approval is given please.

Client Decision:

Action Taken:

2.2.15 Miscellaneous Signs and Markings

Comment

As stated in the audit scope, a road safety audit is not a check on compliance with standards, and the SAT acknowledges that there are further design checks that are to be completed. The SAT highlights the need to undertake these checks and in undertaking this audit, for example, noted the following:

- Give way markings missing from the Stoke Road intersection approach to Orini Road.
- As noted above merge sign at Taupiri Reserve access shows incorrect number of lanes.
- All sign sizes should be checked as appropriate for the prevailing speeds for example the RG17 signs as noted in earlier comments.
- Since five years ago, the supplementary 'give way' board is no longer to be added below the RG – 6R roundabout give way sign.

Frequency Rating: **Infrequent** Severity Rating: **Unlikely**

Designer Response: Thank you and noted. These checks and amendments have been included in the 100% final design.

Safety Engineer: Accept designer's response to make amendments. Happy to remove

give way supplementary roundabout signs, but recommend an extra advance warning roundabout ahead sign, and that the roundabout signs at the give-way area are upsized and located in a way that alerts drivers before they actually get to the limit line.

Client Decision:

Action Taken:

2.3 Barriers

2.3.1 Design Checks

Comment

As noted for the signs and markings drawings, the SAT acknowledges that there are further design checks that are to be completed. The SAT highlights the need to undertake these checks and in undertaking this audit, the SAT noted for example:

- The wire rope barrier has minimum radii criteria to be met and therefore any kinks will need to be smoothed, for example: kink in barrier at chainage 280m at the commencement of the southbound off-ramp.
- Where curved semi-rigid barrier is proposed, such as on the roundabout corners at southern interchange, a recommended clear zone is typically required by the barrier suppliers to ensure that the barrier remains effective on the curves (and a vehicle which strikes the barrier cannot go under the barrier). The SAT acknowledges that the drawings show the standard layout for curved semi-rigid barriers, but highlights the need for a design check to confirm that the required clear zone is provided behind the barrier.
- Texas HT detail – use of a standard elliptical top rail profile would keep barrier consistent with other expressway projects.
- Check the length of need of barriers, particularly in high risk areas such as the outside of curves or structures, for example Ralph Road west approach to overbridge.

Frequency Rating:	NA	Severity Rating:	NA
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Designer Response: Thank you and noted. These checks and amendments have been included in the 100% final design.

Safety Engineer: Accept designer's response.

Client Decision:

Action Taken:

2.3.2 Wire Rope Barrier Overlaps

Comment

The wire rope overlap detail on drawing sheet 4152 indicates that the wire rope overlap is intended to result in all terminal ends on the downstream side of approaching traffic. However, the drawings indicate in places that some of the overlaps are shown with terminal ends facing oncoming traffic.

The wire rope overlap should ideally be orientated so that the terminal end is protected by the barrier overlap to minimise the chance of impact with the anchorage detail and affecting ability to arrest a vehicle in a safe manner.

Frequency Rating: NA Severity Rating: NA

Designer Response: Comment noted. The design of lap terminals facing oncoming traffic was considered in conjunction with geometric design aspects, with the design shown adopted in localised locations as the best fit solution. We therefore propose no further changes.

Safety Engineer: Need Julian Chisnall's sign off to ensure barrier details are correct. Designer's response doesn't read as if they have addressed the issue. Hard to retrofit a fix later, better to agree to get it right now.

Client Decision:

Action Taken:

2.3.3 Local Bridge Barriers Height

Moderate

The local road overbridges are indicated to have barriers of 915mm high, which could allow a cyclist to overtop; particularly given that there is limited space available on the structures to cater for cyclists who may be squeezed against the barrier.

Furthermore, this barrier height is also less than desirable to restrain any pedestrian on the bridge such as maybe required in times of bridge maintenance. In this regard, the SAT refers to the legal requirements for safety in design considerations that will be promulgated in 2016.

Recommendation:

Consider provision of a pedestrian /cycle barrier rail with the traffic barrier.

Frequency Rating: Infrequent Severity Rating: Very Likely

Designer Response: We believe pedestrian/cycle barrier rails are not required due to the following:

- The route is not frequented by pedestrians, there is no requirement to provide footpaths on the structure, and where the bridge is used by pedestrians the very low traffic volumes prevent the need for pedestrians to walk immediately adjacent to the edge barrier.
- The local road bridges are in remote locations.

The location is not frequented by pedestrians therefore we believe the minimum requirement of 915mm, with no provision of a pedestrian/cycle rail, in PR A5.20.10 is applicable.

It is also noted that a determination for compliance with the building code is being sought on this issue. We propose no further action until the outcome of the determination is known.

Safety Engineer: *I don't believe the designer's response fits with our safety in design principles. Brad has noted also that the current design wouldn't meet building code regulations. Recommend barrier height is increased as per BBO's recommendation to meet building code requirements but should at least be a minimum of 1100mm high.*

Client Decision:

Action Taken:

2.3.4 Roadside Hazards Local Roads

Minor

There are several sections of local road that present potential roadside hazards to motorists. These areas include:

- All local roads cut and fill batters with slopes of up to 2:1;
- All local roads: power poles and fences (eg strainer posts) or potentially loose surface material, drainage structures;
- Gordonton Road roundabout at the top of the northbound off-ramp around the southeast corner.

It is acknowledged that traffic volumes are relatively low and that operating speeds are likely to be moderate, which influences the likely crash frequency and severity; nevertheless, in a safe system all hazards should desirably be eliminated or protected.

Recommendation:

Either eliminate all roadside hazards or consider provision of protective barriers, particularly at high risk locations.

Frequency Rating: **Infrequent** Severity Rating: **Unlikely**

Designer Response: *We will reassess the above locations to check the extent of protective barriers, as the local road barriers are designed to protect 2H:1V slopes and update as considered necessary in the 100% design package. Please note all power poles and fences are to be located outside of the respective clear zones, at the top of the cut slope or bottom of the fill slope.*

Safety Engineer: *Issues raised need addressing. Support review so hazards are either eliminated or protected.*

Client Decision:

Action Taken:

2.3.5 Concrete Barrier Trailing End

Comment

The trailing ends of the concrete barrier adjacent to the bridges do not have leading terminal ends, which would result in an abrupt face. The vertical concrete end would be a hazard for any vehicle travelling in the wrong direction on the expressway. Wrong way use of the traffic lanes could result from entering the wrong lanes on the expressway at interchanges.

Furthermore, there is potential for contraflow use of the traffic lanes for emergencies or maintenance, although the expectation would be for control of traffic in these times through traffic management plans.

For example the Mangatoketoke Stream and Komakorau Stream bridges are in relatively close proximity to the Gordonton Road southbound off-ramp and at these locations it would be possible to eliminate the concrete end face by transitioning directly to w-section barrier which is already proposed to the south of both of these structures.

While a full leading terminal may not be required by NZTA, it is likely that a safer terminal end could be used appropriate to the situation, for example a sloping section of concrete barrier, without undue cost increases, or eliminate the face altogether as noted above.

Frequency Rating: NA **Severity Rating:** NA

Designer Response: Thank you and noted. Mangatoketoke Stream and Komakorau Stream Bridges have adopted the SAT team's advice of transitioning directly to w-section barrier instead of overlapping.

Safety Engineer: Accept designer's response to transition w-section barriers instead of overlapping.

Client Decision:

Action Taken:

2.3.6 Median Concrete Barrier Leading Terminal Ends

Minor

The proposed leading end terminal for the concrete median barriers at the overbridge structure uses a transition to w-beam barrier and results in a shoulder of 1.3m and 1.45m for northbound and southbound traffic respectively (sheet 4207).

Therefore the median shoulder abruptly reduces from 3m to a less than desirable shy line offset which may alter vehicle position in the lane. It would be more desirable to provide either adequate shy line offset to barrier or a gradual reduction of the shoulder width potentially using a flare of the leading terminal end.

Recommendation:

Consider provision of either adequate shy line offset to barrier or a gradual reduction of the shoulder width.

Frequency Rating: Infrequent **Severity Rating:** Unlikely

Designer Response: We have assumed the drawing referred to should be DG-R-4157 instead of 4207. 1.3m and 1.45m shown on DG-R-4157 is incorrect and the minimum shoulder width is 1.5m, this has been updated for the 100% design package. However the minimum 1.5m shoulder is only applied on the inside of the curve approaching Orini Rd bridge pier protection (heading northbound), where shy line offset is not of concern. In all other locations adequate shy line offsets are applied, with a minimum of 2.4m.

Safety Engineer: Accept designer's response.

Client Decision:

Action Taken:

Released under the Official Information Act 1982

3. Audit Statement

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. The problems identified have been noted in this report.

Signed:

Date: 17 December 2015

s 9(2)(a) BE, ME (Civil), CPEng, MIPENZ
Technical Director, TDG, Tauranga

Signed:

Date: 17 December 2015

s 9(2)(a) BE, ME (Civil), MIPENZ, MITE
Senior Consultant, Traffic Planning Consultants, Auckland

Signed:

Date: 17 December 2015

s 9(2)(a) BSc (Eng), BEng(Hons), MSc(Eng), CPEng, MIPENZ
Principal Transportation Engineer, MWH, Auckland

Designer: Name..... Position.....

Signature..... Date.....

Safety Engineer: Name..... Position.....

Signature..... Date.....

Project Manager: Name..... Position.....

Signature..... Date.....

Action Completed: Name..... Position.....

Signature..... Date.....

Project Manager to distribute audit report incorporating decision to designer, Safety Audit Team Leader, Safety Engineer and project file. Date:.....