

Mackays to Peka Peka (M2PP)
Kāpiti Expressway
SH1/OTAIHANGA ROAD
ROUNDABOUT

ROAD SAFETY AUDIT
of the DETAIL DESIGN

A REPORT PREPARED FOR
NZ TRANSPORT AGENCY

Hawke's Bay office:
PO Box 28 208, Havelock North 4157

Tel: (06) 877 8040
Mob: 0274 978 031
E-mail: steve@trafficplanning.co.nz

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Prepared By	Jos Vroegop (TPC), Steve Reddish (TPC), Jon England (MWH)
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1.0 INTRODUCTION

1.1 Road safety audit definition and purpose

Road safety audit is a formalised process to:

- identify potential road or traffic safety concerns for all road users and others affected by a road project
- ensure that the measures to eliminate or reduce the concerns are considered fully

It can be carried out at the following project stages:

- Feasibility / Concept stage
- Scheme / Preliminary design stage
- Detailed design stage
- Post Construction stage

This is a Detail design stage safety audit.

The aim of this road safety audit is to identify potential road safety concerns and bring them to the notice of the project designers and the client. The recommendations are intended to be indicative only to focus the designer on the type of improvements that may be appropriate. They are not intended to be prescriptive and other ways of mitigating the road safety concerns identified should also be considered.

The procedure set down for road safety audits in the NZ Transport Agency Guideline “Road Safety Audit Procedures for Projects” (November 2004) is that this is a report to the client who then refers the report to the designer. The designer should consider the report and comment to the client on each of the concerns raised, including their cost implications where appropriate, and make a recommendation to either amend the design or reject the audit report recommendation. The client then makes the final decision on each issue raised and informs the designer. Copies of both the designer’s comments to the client and the client’s decisions should be given to the safety audit team leader (for information only).

1.2 The project

The project for which this is the road safety audit is the proposed roundabout to improve road safety at the existing T-intersection of SH1 and Otaihanga Road, located between Paraparaumu and Waikanae, Kāpiti.

The principal drawings utilised for the safety audit of this intersection improvement are:

- General arrangement: M2PP-45M-D-DWG-0001

- Plans and long sections: M2PP-45M-D-DWG-0002 & 0003
- Pavement design: M2PP-45M-D-DWG-0004 & 0005
- Typical cross sections: M2PP-45M-D-DWG-0006
- Kerb and barrier details: M2PP-45M-D-DWG-0007 to 0009
- Roadmarking: M2PP-45M-D-DWG-0010
- Signage details: M2PP-45P-D-DWG-0001 to 0004
- Proposed services: M2PP-45C-D-DWG-0002
- Stormwater plans: M2PP-45K-D-DWG-0001 to 0017
- Planting: M2PP-45R-D-DWG-0001& 0002

All drawings were annotated Rev A and dated 30.04.13.

1.3 Previous safety audit

A preliminary design stage safety audit was undertaken by the current safety audit team in August 2012 and the findings noted in a report dated 24 August 2012. Two earlier road safety reviews of the roundabout proposal were also carried out by the current safety audit team in January and March 2012.

1.4 The safety audit team

The road safety audit was carried out, as far as practicable, in accordance with the NZTA Guideline “Road Safety Audit Procedures for Projects” (November 2004) by:

- Jos Vroegop, Senior Consultant, Traffic Planning Consultants Ltd, Auckland
- Steve Reddish, Senior Associate, Traffic Planning Consultants Ltd, Hawke’s Bay
- Jon England, Senior Road Safety Engineer, MWH New Zealand Ltd, Wellington

The SAT attended a briefing meeting at the offices of the M2PP Alliance, Wellington, on Wednesday 1 May 2013 and carried out a desk top review that day of the drawings provided at the briefing. No site visit was undertaken as the members of the safety audit team were already familiar with the site from previous site visits.

1.5 Report format

The safety rating process for audits has been reviewed as part of a draft update to the safety audit guidelines. Although the revised draft guidelines have yet to be formally issued, most NZTA regions have already requested that they be used and consequently

the draft ranking framework has been applied to this audit. Therefore, the potential road safety problems identified have been ranked using the ranking weighting defined in Table 1 and the categories of concern defined in Table 2.

Table 1: Assessment Matrix

Likelihood of Fatality or Serious Injury	Probability of a Crash Occurring			
	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 2: Categories of Concern

CONCERN	Suggested Action
Serious	Serious 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 injury consequence
Moderate	Moderate concern that should be addressed to improve overall safety
Minor	Minor concern that may be addressed to improve overall safety.
Comment	A concern or an action that may be outside the scope of the RSA, but which may improve overall design or be of wider significance.

All potential concerns, comments and recommendations set out in this safety audit report should be noted and acted upon if appropriate.

1.6 Disclaimer

The findings, opinions, and recommendations in this report are based on an examination of available relevant plans and the specified road and environs, and might not address all issues existing at the time of the audit. The report also deals with

technical matters. Readers are urged to seek specific advice on particular matters and not rely solely on the report. While every effort has been made to ensure the accuracy of the report, it is made available strictly on the basis that anyone relying on it does so at their own risk without any liability to members of the audit team or their organisations.

2.0 SAFETY AUDIT FINDINGS

Preamble:

The safety audit team (SAT) considers that, overall, the designers have produced a design that will significantly improve road safety at the SH1/Otaihanga Road intersection. The SAT notes that most issues raised in the safety audit of the preliminary design have been addressed in the detail design. However, the SAT has revisited two issues (median barrier and edge kerb design) and on reflection has revised its view compared to the previous safety audit.

2.1 Moderate Concern – Median barrier protection

Probability of Crash Occurring – Occasional

Likelihood of Serious/Fatal Injury – Likely

Outcome – Moderate

In the safety audit of the preliminary design the SAT recommended that the design provide for the retrofitting of wire rope median barrier. Whilst this has been done, the SAT is of the view that, having regard to the safe system approach to design, consideration should be given to installing wire rope barrier along the median from the outset.

The SAT considers the following factors influential in revising its opinion to one of early implementation of a wire rope barrier:

- (1) The southbound approach curve has a horizontal radius of 330m. Horizontal curves with a radius of 300 – 450m are known to be difficult to read and the proposed radius of this curve is within this range. In addition, the ability to read the curve will be exacerbated by the trees on the inside of the curve which will prevent a full view of the carriageway around the curve and so improve its “readability”, despite the presence of the proposed concrete median. This can lead to the risk of vehicle loss-of-control and crossing the median into northbound traffic exiting the roundabout.
- (2) The kerbed noses of the raised medians on both the northbound and southbound approaches will not be offset from the centreline markings and there is consequently a higher risk of a nose being struck with resultant loss of control.
- (3) The wire rope barriers would also cover the risk of any crashes at the northbound and southbound merge areas resulting in a vehicle crossing the concrete median.

- (4) Installation of wire rope barrier would also improve delineation of the southbound approach curve; especially at night given that reflectors are normally applied to the top of the wire rope supports.

Recommendation:

Replace the concrete median with a wire rope barrier on both SH1 approaches and terminate the barriers prior to the splitter islands at the roundabout.

<p>Designer Response</p>	<p>The design shall be amended to include wire rope median barrier on the southbound approach. This will address the SAT concerns regarding the horizontal curve.</p> <p>We note, to address the drainage issues effectively, we have retained the designed concrete median. Removal of the concrete median would add additional capital costs of approximately \$50k and would require significant redesign to the drainage system.</p> <p>The northbound approach has not been altered, as the possible benefits do not outweigh the costs on a straight approach with good sight distances.</p> <p>We note KCDC's aspirations for the existing State Highway to revert to a local arterial route without wire rope medians.</p> <p>We also note if required wire rope median could be installed on the northbound approach post construction.</p>
<p>Safety Engineer:</p>	<p>Agree with the designers comments that the wire rope barrier is only required on the northern leg of the roundabout. As long as fully mountable kerbs are used on the median island the wire rope barrier can be installed centrally on the island. The end terminal will need to be installed on the pavement rather than the island and at a sufficient distance from the nose of the island to ensure that the development length is achieved.</p>
<p>Client Decision:</p>	<p>At detailed design stage, the designer shall include for a WRB to the Southern approach noting the Safety Engineer's comments on installation.</p>
<p>Action Taken:</p>	<p>Mountable kerbs have been used throughout the project as per the details on drawing M2PP-45M-D-DWG-0008.</p> <p>Wire Rope Barrier has been added to the northern leg of the roundabout as shown on Rev 2 of the "For Construction" Drawings. A mountable kerb with 2H:1V face has been adopted adjacent to the WRB to cater for drainage and vehicle overrun.</p>

2.2 Moderate Concern – Landscaping and visibility of the roundabout

Probability of Crash Occurring – Occasional

Likelihood of Serious/Fatal Injury – Likely

Outcome – Moderate

From a road safety perspective, it is important that the roundabout is clearly visible to approaching motorists so that they slow down prior to the roundabout, particularly when traffic is light (eg at night time). The warning of and the conspicuousness of the roundabout is achieved through a number of mechanisms, including ADS signage, warning signage, visibility of the central island and street lighting.

In terms of visibility of the central island, this is achieved by the combination of mounding, landscaping and signage. The drawings provided state that mounding of the central island will be up to only 0.5m at the centre of the island with planting up to 1m (see drawing 45R-0001). There is also reference to 5 zones of planting within the central island, but these are not defined on the drawing, and the plants specified do not necessarily provide sufficient contrast with the surroundings.

The SAT is of the view that the mounding needs to be more substantial (eg up to 1.5m at the centre of the island) and the planting needs to provide sufficient contrast from the surrounding vegetation when viewed from a driver's perspective in order to make the central island suitably visible to approaching drivers. Obviously, the overall landscaping design must still maintain the necessary sight distance criteria per Austroads Guide to Road Design (GRD) Part 4B. It should also be noted that high planting that restricts visibility across the roundabout (outside the required sight distance criteria) generally encourages slower entry onto roundabout.

In addition, it is noted on signage layout drawing 45P-0001 that the PW-69 chevron boards on the central island are not positioned in the direct line of sight of approaching motorists before they enter the curve through the limit line and so would not enhance the visibility of the roundabout from some distance back.

Recommendations:

- a. *Increase the mounding of the central island (eg at least 1.5m at the centre of the island) and ensure that the specified planting needs provides sufficient contrast from the surrounding vegetation when viewed from a driver's perspective, whilst maintaining the required cones of visibility per Austroads GRD Part 4B.*
- b. *Install two PW-69 chevron boards side by side for the three multi-lane approaches and position the chevron boards so that they are in the direct line of sight of motorists at approximately 50m from the limit line.*

Designer Response	<p>a. The roundabout mounding has been increased to approximately 1.5m as per the SAT recommendations.</p> <p>b. PW-69 Chevron Boards have been re-positioned as per the SAT recommendations</p>
Safety Engineer:	<p>a. Agree with auditor and designer. Design team need to ensure that the planting contrasts with the background vegetation.</p> <p>b. Agree with the audit team and designer.</p>
Client Decision:	The designer shall increase the roundabout mounding to 1.5m and position the chevron boards in direct line of sight for motorists.
Action Taken:	Changes were included in the "For Construction" Drawings.

2.3 Moderate Concern – Signage on approaches to the roundabout

Probability of Crash Occurring – Infrequent

Likelihood of Serious/Fatal Injury – Likely

Outcome – Moderate

As noted in item 2.2 above, advance destination signs (ADS) and advance warning signs are important measures to advise/warn motorists of the upcoming roundabout. These measures are particularly important in higher speed rural/semi-rural areas where such intersections are infrequent and drivers can encounter the roundabout unexpectedly.

- (1) The signage drawing 45P-0001 does not show any advance warning PW-8 signs for any of the approaches to the roundabout. High impact gated warning signs are important to warn drivers, though they are always needed in combination with other measures as most drivers need a range of visual cues.
- (2) ADS signage is shown on the SH1 approaches located some 500m prior to the roundabout. At this distance, the impact and the messages of the signs can be lost on many drivers by the time they arrive at the roundabout. Locating the signs closer to the roundabout or, preferably, installing repeat ADS signage closer to the roundabout would overcome this problem.
- (3) On the Otaihanga Road approach to the roundabout ADS signage is shown both prior to and after the railway crossing. The SAT considers that drivers need to concentrate on the railway crossing without being distracted by other signage and so ADS signage should only be installed between the railway line and SH1.
- (4) Additionally, on Otaihanga Road, two variants of the ADS sign are shown, one diagrammatically with a roundabout (sign 3) and one without (sign 3A). Given the uphill approach to the roundabout on Otaihanga Road, the intersection form will not be readily apparent to motorists and the diagrammatic form of the ADS will be

an important cue as to what is ahead. In addition, the option of just left and right arrows on the ADS could be confusing to some motorists who may think the sign refers to the entrance to the Southward Car Museum.

- (5) If the ADS sign on Otaihanga Road is installed between the railway line and the car museum entrance, an additional sign will be needed between the car museum entrance and SH1 to advise visitors leaving the museum which lane to be in prior to the roundabout.

Recommendations:

- a. Install gated PW-8 roundabout warning signs on all approaches to the roundabout.
- b. Install repeat ADS signage on the SH1 approaches or relocate the proposed ADS signage closer to the roundabout (eg at approx. 300m).
- c. Do not install ADS signage to the northwest of the railway line on Otaihanga Road.
- d. Delete the sign 3A option for ADS signage on Otaihanga Road.
- e. Ensure that there is signage located between the car museum and SH1 to advise visitors leaving the museum which lane to be in prior to the roundabout.

Designer Response	<ol style="list-style-type: none"> a. PW-8 roundabout signs will be gated as per the SAT recommendation which is consistent with the raised median. b. The Design Team investigated moving and / or repeating the ADS signs. However, sight distance is limited in the areas where there is suitable space. Therefore the signs have remained in the existing position. c. ADS signage northwest of the railway line has been relocated southeast of the railway line. d. Sign 3A has been removed. e. The ADS northwest of the railway line on Otaihanga Road has been relocated northeast of the exit to the car museum and will be placed in an optimised position for both visibility to both Otaihanga Road and car museum users.
Safety Engineer:	<ol style="list-style-type: none"> a. Agree with auditors and designer. b. Agree with auditor that the sign needs to be repeated closer to the roundabout. Consideration needs to be given to the impacts of not achieving the sight distance vs the additional clarity gained by providing the additional information to the driver. c. Agree with auditors and designer. d. Agree with auditors and designer
Client Decision:	Agree with the above; if sight distance is an issue for the south-bound direction, we should be looking to install an advance repeater sign.

Action Taken:	<ul style="list-style-type: none"> a. Changes were included in the "For Construction" Drawings. b. After discussion with the Safety Engineer, the ADS on the northbound approach has been moved to 360m from the roundabout. This provides direction approximately 90m closer to the roundabout. This provides greater clarity for approaching vehicles. The ADS on the southbound approach is currently located in the most appropriate position. It was agreed with the Safety Engineer to retain the sign in its current position. The operational performance is to be monitored after opening. c. Changes were included in the "For Construction" Drawings. d. Changes were included in the "For Construction" Drawings. e. Changes were included in the "For Construction" Drawings.
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2.4 Minor Concern – Other signage issues

Probability of Crash Occurring – Infrequent

Likelihood of Serious/Fatal Injury – Unlikely

Outcome – Minor

- (1) Prior to the railway crossing on Otaihanga Road, a single level crossing ahead sign is proposed (sign 11 drawing 45P-0001). To maximise the impact of the advance warning, gated signs (WX1R and WX1L) are recommended, particularly on roads with carrying 2,000 vehicles per day or more. Whilst the SAT does not know the volume of traffic on Otaihanga Road, it nevertheless considers that there is a safety benefit in installing gated level crossing ahead signs.
- (2) The SH1 northbound departure leg from the roundabout has two lanes for approximately 175m. As this exit is on a curve, drivers will not readily see the need to merge from two lanes to one. Whilst PW-43.3 two lanes to one lane warning signs are shown on drawing 45P-0001 at the merge, the SAT considers that gated lane reduction ahead warning signs (PW-43.2) should be installed at approximately 100m prior to the merge to minimise the risk of late unsafe lane changing at the merge.
- (3) Drawing 45P-0001 indicates that a PW-17.1 Keep Left Twin Disc sign is proposed at the end of the proposed median island. Whilst noting that the SAT is recommending that this be replaced by WRB, it is important to provide an appropriate target value for keep left signs in semi-rural areas. For this reason, RG-17 Keep Left signs should be used in place of RG-17.1 signs.

Recommendations:

- a. Install gated WX1R and WX1L level crossing ahead signs on Otaihangā Road.
- b. Install gated PW-43.2 lane reduction ahead warning signs on the SH1 northbound exit approximately 100m prior to the merge.
- c. Ensure that RG-17 Keep Left signs are provided wherever Keep Left signs are required in place of RG-17.1 twin disc signs.

Designer Response	<ol style="list-style-type: none"> a. SAT recommendations have been taken on board and gated signs are to be installed. b. Gated PW-43.2 gated signs have been relocated 100m prior to the merge on the northbound exit only. c. Noted and design amended accordingly
Safety Engineer:	<ol style="list-style-type: none"> a. Agree with SAT and designers. b. Agree with SAT, Designers to confirm that an additional two signs will be provided and not that the signs will be relocated. c. Agree.
Client Decision:	<ol style="list-style-type: none"> a. Install gated signs to the approach to the L/C b. Install gated merge signs prior to the north-bound merge c. Use RG-17 Keep Left signs in place of RG-17.1 signs.
Action Taken:	<ol style="list-style-type: none"> a. Changes were included in the "For Construction" Drawings. b. Gated PW43.2 signs are to be installed in addition to two gated PW-43.3 signs prior to the merge on the northbound exit and the drawings updated accordingly. c. Changes were included in the "For Construction" Drawings.

2.5 Minor Concern – Lane marking on the roundabout approaches

Probability of Crash Occurring – Infrequent
 Likelihood of Serious/Fatal Injury – Very unlikely
Outcome – Minor

The development from one lane to two through lanes on each of the approaches to the roundabout is marked with continuity lines that essentially direct through traffic into a single lane. On the SH1 approaches, this can lead to late, unsafe lane changing closer to the roundabout when drivers realise they can use either lane.

Recommendation: Remove the continuity lines where one lane develops into two through lanes on the SH1 approaches to the roundabout.

Designer Response	Continuity line removed where one lane develops into two giving road users the option to choose the appropriate lane.
Safety Engineer:	Agree

Client Decision:	Agree with Safety Auditor's recommendations
Action Taken:	Changes were included in the "For Construction" Drawings.

2.6 Minor Concern – Local access road appearance at the roundabout

Probability of Crash Occurring – Occasional
Likelihood of Serious/Fatal Injury – Unlikely

Outcome – Minor

In the safety audit of the preliminary design, the SAT noted the concern that the local access road serving the few properties on the eastern side of the roundabout should have the appearance of a driveway and not a road so that motorists are not confused about which exit to take and brake or turn unexpectedly on the roundabout.

Many motorists when looking at diagrammatic advance destination signs (ADS) count which exit they are to take when approaching a roundabout. The proposed ADS signs do not show a "stub" on the roundabout diagram to indicate the local access road so there is the risk of an unfamiliar driver looking to exit onto the local road if that road appears to be a bona fide exit. The SAT considers that a safer outcome would be generated if the local road does not appear to be an integral part of the roundabout operation, but is made to look more like a driveway or similar.

Given that the local access road is a cul-de-sac, signage such as No Exit would also reinforce the nature of the access road.

It is noted that the shared path crosses the mouth of the local road access at the roundabout. Signage and marking should be installed to require cyclists and pedestrians to give way at the access to avoid the situation of a vehicle stopping on the roundabout to give way to a cyclist/pedestrian.

Recommendations:

- a. Design the local road to look like a driveway by means of surface treatment at the roundabout (eg concrete dish channel, concrete strip, surface strip of different colour/texture).
- b. Install gated No Exit signage or similar on the local access road at the roundabout.
- c. Install appropriate signage and marking on the shared path at the local access road to require cyclists and pedestrians to give way to vehicles when crossing the local access road.

Designer Response	a. Concrete dished channel has been placed along the entrance to the local road to clearly delineate access.
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	<ul style="list-style-type: none"> b. Additional signage incorporated into the design. c. A cyclist resting station will be installed at the crossing point to indicate the need to give way to vehicles
Safety Engineer:	<ul style="list-style-type: none"> a. Agree with designers proposed treatment. b. Agree c. Designer to consider the provision of small give way signs to ensure that it is clear that cyclists need to give way to vehicles on the carriageway.
Client Decision:	Agree with Safety Auditor's recommendations; action is with the Designer
Action Taken:	<ul style="list-style-type: none"> a. Changes were included in the "For Construction" Drawings. b. Changes were included in the "For Construction" Drawings. c. Cyclist holding rails are to be installed with reduced size RG6 'Give Way' signs to be mounted on them as per the drawings.

2.7 Minor Concern – Skid resistance

Probability of Crash Occurring – Occasional

Likelihood of Serious/Fatal Injury – Unlikely

Outcome – Minor

It is noted that on pavement details drawing 45M-0005, the carriageway surface on the approaches to and around the roundabout is specified to be SMA 11 with a PSV of 54. The SAT understands that specifications for skid resistance of surfacing require the design to comply with NZTA T10 Specification 2012. Roundabout approaches are considered Category 1 resulting in the highest IL requirement of 0.55. This will require a suitably selected aggregate to provide the required skid resistance. The proposed PSV 54 aggregate does not comply without additional on-road performance evidence. . It is important from a road safety perspective that appropriate skid resistance is provided and maintained through the roundabout and its approaches.

Recommendation: *Ensure that the surface treatment for the roundabout and approaches provides appropriate skid resistance.*

Designer Response	The SAT concern is noted and the design has been reviewed and an error in the calculations resulted in a lower than required PSV indicated on the drawings. The PSV of the surfacing is to be increased.
Safety Engineer:	The design team need to ensure that the requirements of M/23 are met however in terms of the best stone to be used and the life of a particular stone this is an issue for the Operations team.

Client Decision:	Agree with Safety Auditor's recommendations. Designer to confirm the proposed PSV.
Action Taken:	The PSV of the surfacing on the approach to, and around the roundabout has been increased to 72.

2.8 Moderate Concern – Hazards not protected or appropriately designed

Probability of Crash Occurring – Infrequent

Likelihood of Serious/Fatal Injury – Likely

Outcome – Moderate

Based on drawing 45M-0007, it appears that most roadside hazards will be protected by TL-3 W-section guardrail. However, the following hazards arising from the detail design are not shown as being protected:

- Drawing 45C-0002: new power pole at the southwestern quadrant of the roundabout (between SH1 northbound approach and Otaihanga Road).
- Drawings 45K-0002 and 45K-0011: sump to swale headwalls along the western side of the SH1 northbound approach.
- Drawings 45K-0002 and 45K-0012: type 1 swale outlet structure on the western side of the SH1 northbound approach just prior to the roundabout.
- Drawings 45K-0002 and 45K-0010: swale along the western side of the SH1 northbound approach designed with 1:4 slopes – whilst traversable by many vehicles, higher centre of gravity vehicles such as SUVs can overturn on a 1:4 slope leading to injury crashes – 1:6 slopes are better to minimise the risk of vehicles overturning.

On drawings 45K-0003 and 45K-0010, the shallow swales along both sides of Otaihanga Road have annotations for “check dams” and “swale outlets type 2”. No detail information is provided on the dams or type 2 outlets. Consequently, the SAT is unable to fully assess the potential safety risk.

Similarly, on drawing 45K-0002 a swale outlet type 2 is shown at the southeastern quadrant of the roundabout (immediately south of the local road access) and with no detail information on this type of outlet, the SAT is unable to assess the potential safety risk.

On drawing 45M-0006, the cut batters on Otaihanga Road are shown with 1:3 slopes. Slopes this steep can cause a vehicle to overturn if traversed by a run-off-road vehicle.

Recommendations:

- a. Provide barrier protection for the various hazards along the western side of the SH1 northbound approach to the roundabout, including the new power pole at the southwest quadrant of the roundabout.
- b. Review the drainage features on both sides of Otaihanga Road to ensure that they do not present any roadside safety hazards, or redesign/protect as appropriate.
- c. Review whether the type 2 swale outlet at the southeastern quadrant of the roundabout poses a potential safety risk and redesign/protect if necessary.
- d. Flatten the 1:3 cut batters on Otaihanga Road if possible or protect in association with b. above.

Designer Response	<ol style="list-style-type: none"> a. Locations of the barrier have been reviewed and updated to provide additional protection from the hazards identified by the SAT. b. All drainage features are to be protected using safety barrier. c. Refer b. d. Refer b.
Safety Engineer:	Agree with designers response to items a-d. Design team to provide updated drawings to NZTA for review.
Client Decision:	Agree with Safety Engineer's comments. Action is with the Designer.
Action Taken:	As requested the drawings indicating the locations of the barriers and protection of all features are included with this report.

2.9 Moderate Concern – Design issues associated with barriers

Probability of Crash Occurring – Occasional

Likelihood of Serious/Fatal Injury – Likely

Outcome – Moderate

- (1) The full extent of the TL-3 W-section barriers shown on drawing 45M-0007 is not apparent and no end terminals are shown, though a leading end terminal is detailed on drawing 45M-0009.
- (2) No gaps are shown in the proposed barriers for:
 - (i) the access to the shared path on the eastern side of the SH1 southbound approach at approx. chainage 220 and
 - (ii) the farm access on the western side of the SH1 southbound approach at chainage 100.
- (3) A vertical face kerb is shown in front of the guardrail on the eastern side of the southbound approach for about 50m from approx. chainage 320. A vehicle hitting

the kerb at speed could be “launched” and not hit the barrier in a way that would be effective to minimise any injury outcome.

Recommendations:

- a. Specify the full extent of the proposed barriers.
- b. Ensure all barrier terminations are per NZTA specifications.
- c. Introduce appropriately designed gaps in the barriers for the shared path on the eastern side of the SH1 southbound approach at chainage 220 and the farm access on the western side of the SH1 southbound approach at chainage 100.
- d. Move the kerb on the eastern side of the southbound approach starting at chainage 320 back to be in line with the face of the guardrail.

Designer Response	a, b, c. The barrier extent and details shall be clearly shown with appropriate terminals. Gaps in the barriers for crossing points identified with sufficient tapers and terminals. d. The kerb on the eastern side of the southbound approach has been changed to a mountable kerb and the barrier relocated to provide a setback of over 2.0m to provide room for the footpath.
Safety Engineer:	Agree with designer’s response on a-d. As above, drawing to be provided to NZTA for review.
Client Decision:	Agree with Safety Engineer’s comments. Action is with the Designer.
Action Taken:	As requested the drawings indicating the locations of the barriers and protection of all features are included with this report.

2.10 Minor Concern – Use of vertical face kerbs

Probability of Crash Occurring – Infrequent
Likelihood of Serious/Fatal Injury – Unlikely

Outcome – Minor

Vertical face kerbs in higher speed environments can pose a safety hazard if hit as vehicles are more likely to be deflected further or drivers lose control than in lower speed (urban) environments. In the safety audit of the preliminary design, the SAT made specific reference to using mountable kerbs on all traffic islands, but should have specified using mountable kerbs in all locations, given the 80 km/h speed environment.

Recommendation:

Replace vertical face kerbs with mountable kerbs throughout the project.

Designer Response	Kerbs have been changed to semi-mountable profile kerbs throughout.
Safety Engineer:	Designer to advise if it is possible to use mountable kerbs throughout the project and if possible to incorporate these.
Client Decision:	Agree with Safety Engineer's comments. Action is with the Designer.
Action Taken:	Mountable kerbs have been provided in place of vertical face kerbs throughout the project.

2.11 Minor Concern – Point of change of grade on Otaihanga Rd approach

Probability of Crash Occurring – Infrequent

Likelihood of Serious/Fatal Injury – Unlikely

Outcome – Minor

In the safety audit of the preliminary design, the SAT noted:

“The Otaihanga Road approach has a proposed constant 5.4% gradient with an instantaneous change of grade at the roundabout. However, based on the long section shown on drawing CV-GP-138, this change of grade occurs prior to the limit line at the roundabout which means that the limit line will not be in the view of approaching drivers.”

The SAT recommended that the instantaneous change of grade occur at and not prior to the limit line and, based on the decision, understood that this was to be done. However, the long section for Otaihanga Road (drawing 45M-0002) shows the change in grade still occurring prior to the limit line.

Recommendation:

On the Otaihanga Road approach, design the instantaneous change of grade to occur at and not prior to the limit line at the roundabout.

Designer Response	Design has been updated to give instantaneous change of grade which, is to occur at the limit line
Safety Engineer:	Designer to ensure that the limit line is painted on the Otaihanaga Rd side of the change in grade.
Client Decision:	Agree with Safety Engineer's comments. Action is with the Designer.
Action Taken:	The point of change of grade on the Otaihanga Rd approach has been moved so that the limit line is visible to approaching drivers, this has been communicated to the Site Representatives and changes were included in the “For Construction” Drawings.

2.12 Minor Concern – Unsealed narrow shoulders on Otaihanga Road

Probability of Crash Occurring – Occasional
Likelihood of Serious/Fatal Injury – Unlikely

Outcome – Minor

The typical cross section for Otaihanga Road on drawing 45M-0006 shows the pavement does not include the shoulders. Narrow and unsealed shoulders are a known safety problem and can lead to crashes as there is no recovery area for drivers who stray out of the traffic lane to the side of the road.

Recommendations:

- a. Seal the shoulders on Otaihanga Road.
- b. Where possible increase the shoulder width (eg to 750mm).

Designer Response	<ol style="list-style-type: none"> a. Shoulders are to be sealed b. SAT comments regarding shoulder widths have been noted and the shoulder width has been increased where possible.
Safety Engineer:	<ol style="list-style-type: none"> a. Agree b. Designer to provide updated drawings noting the location where 750mm width has not been achieved.
Client Decision:	Agree with Safety Engineer's comments. Action is with the Designer.
Action Taken:	<ol style="list-style-type: none"> a) All shoulders on Otaihanga Rd are to be sealed. b) As discussed and agreed with the Safety Engineer the location where the shoulder width is <750mm is acceptable.

2.13 Moderate Concern – Facilities for pedestrians and cyclists

Probability of Crash Occurring – Occasional
Likelihood of Serious/Fatal Injury – Likely

Outcome – Moderate

Whilst detail for a pedestrian ramp is shown on drawing 45M-0008, no details have been provided for angled cycle ramps to safely take cyclists from the carriageway shoulder onto the shared path and back onto the carriageway.

In addition, if a southbound cyclist leaves the carriageway at the path to the local access road, there is no signage to direct him/her to the shared path if they intend

turning right onto Otaihanga Road. Similarly a cyclist coming from Otaihanga Road and intending to head south needs to be directed onto the local access road and thence the path to the shoulder after using the facility to cross SH1 on the northern side of the roundabout.

No detail has been provided as to how the footpath on the western side of SH1 south of the roundabout ties in with the existing shoulder or other pedestrian facility.

The kerb layout drawing 45M-0007 does not show any gaps or dropped kerbs for the various pedestrian and cyclist ramps.

The detail for the pedestrian ramp on drawing 45M-0008 shows tactile ground surface indicators (TGSI) are to be applied for the benefit of the visually impaired. The SAT questions the benefit of installing these indicators as the visually impaired find it very difficult to cross at roundabouts as, at roundabout exits, they cannot tell from sound if a vehicle is circulating on the roundabout or exiting. Consequently, roundabouts in high speed areas in particular should be avoided by the visually impaired.

Recommendations:

- a. Provide detail design for safe angled cycle ramps and their tie-ins from and onto carriageway shoulders.
- b. Provide appropriate signage for cyclist movements to/from Otaihanga Road so that cyclists are directed to safe crossing points.
- c. Ensure that the footpath on the western side of SH1 south of the roundabout ties in with the existing shoulder in a safe and appropriate manner.
- d. Ensure that the kerb layout drawings clearly indicate where pedestrian and cyclist ramps are to be constructed.
- e. Review the necessity for tactile ground surface indicators to be installed on the pedestrian ramps.

Designer Response	<ol style="list-style-type: none"> a. Safe angled cycle ramps and their tie-ins from and onto carriageway shoulders have been included in the design b. The designers believe significant signage already exists on site to sufficiently guide cyclists and pedestrians around the roundabout. c. Footpath on the western side of SH1 south of the roundabout is to tie in with the existing shoulder. d. Kerbing drawing amended to clearly indicate pedestrian and cyclist ramp e. Tactile ground surface indicators have been removed
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Safety Engineer:	a,c,d – Agree with SAT and designer. Design team to provide drawings to NZTA for review. b. Agree with SAT. Further direction signage is required for cyclists/ pedestrians using the cycle path
Client Decision:	Agree with Safety Engineer's comments. Action is with the Designer.
Action Taken:	Additional cyclist direction signs have been included in the drawings indicating directions North, South and to Otaihanga Road. Changes were included in the "For Construction" Drawings. Drawings indicating the cycle ramp arrangement, additional signage, and pedestrian/ cycleway details are included with this report.

2.14 Minor Concern – Lighting at the roundabout and local access road

Probability of Crash Occurring – Infrequent
Likelihood of Serious/Fatal Injury – Unlikely
Outcome – Minor

The lighting drawing provided to the SAT shows a reasonable overall level of lighting that will enhance the visibility of the roundabout.

Two possible issues of safety concern are:

- (1) The potential glare from the street lights located on the central island which are located in front of traffic approaching the roundabout.
- (2) No lighting is shown for the local access road and the level of lighting at the intersection of the local road and the roundabout is lower than the other potential vehicle conflict points on the roundabout.

Recommendations:

- a. *Ensure that there will be no glare from the lights located on the central island affecting drivers approaching the roundabout, especially those approaching uphill from Otaihanga Road.*
- b. *Provide improved lighting at the intersection of the local road and the roundabout and along the local access road itself.*

Designer Response	<p>a. The lights have been removed from the roundabout and relocated to the outer circumference of the roundabout.</p> <p>b. The lighting design has been amended to improve the lighting levels at the access to the local service road.</p>
Safety Engineer:	Agree with designers response
Client Decision:	Agree with Safety Auditor's comments and I'm satisfied with the Designer's response.
Action Taken:	<p>Further to our discussion with the Safety Engineer, hazard markers are to be removed from the lighting columns.</p> <p>NZTA Safety Engineer to provide additional information on alternative options for the column foundations. This information is required by the 16th August if changes are to be made to the design.</p>

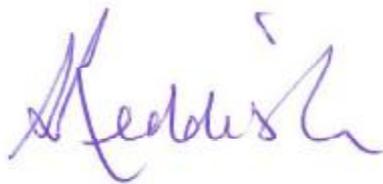
3.0 AUDIT STATEMENT

We certify that we have used the documents noted in section 1.2 to identify features of the project that could be changed, removed or modified in order to improve safety. The problems identified have been noted in this report, together with recommendations, which should be studied for implementation.



Signed:..... Date: 10 May 2013

Jos Vroegop, BE, ME, MIPENZ, MITE
Senior Consultant
Traffic Planning Consultants Ltd, Auckland



Signed:.....Date: 10 May 2013

Steve Reddish, BSc(Eng), MIPENZ, MCIHT, FITE, Dip TE
Senior Associate
Traffic Planning Consultants Ltd, Hawke's Bay



Signed:.....Date: 10 May 2013

Jon England, BE (Civil), MIPENZ, CPEng, IntPE (NZ), RPEQ
Senior Road Safety Engineer
MWH New Zealand Ltd

